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Preliminary Groundwater Benefit Zone Study
Santa Clara County, California

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Santa Clara Valley Water District

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1 EXECUTIVE SUMMARY

The Santa Clara Valley Water District (District) Act gives the District Board of Directors the authority to establish, amend, and revise groundwater charge zones (also called groundwater benefit zones or Zones, District Act Section 3) and to levy and collect groundwater charges within a zone or zones that benefit from the recharge of underground water supplies or the distribution of imported water (District Act Section 26). The two existing Zones, W-2 and W-5, were established in 1963 and 1977, respectively. Zone W-2 generally covers the Santa Clara Plain in North County while Zone W-5 generally covers the Coyote Valley and Llagas Subbasin in South County (Figure ES- 1) where Santa Clara Plain, Coyote Valley and Llagas Subbasin are groundwater management areas delineated by the District (Figure ES- 2). California Department of Water Resources (DWR) defines the Santa Clara Plain and Coyote Valley areas as the Santa Clara Subbasin.

The purpose of the Groundwater Benefit Zone Study (Study) is to provide a comprehensive review of the Zones to ensure they reflect areas where groundwater users receive similar benefits from current and planned District groundwater management activities. Although the District is not aware of any specific problems with the existing Zone designations, the District has received requests for exemptions and recognizes that it is important for the District to periodically undertake an updated analysis of the Zones, and revise the boundaries if appropriate. The Study is based on evaluation of the subsurface characteristics that govern the movement of groundwater (called hydrogeologic characteristics) and the ways that District activities benefit groundwater users. These benefits are derived not only from direct groundwater recharge with surface water supplies (called managed aquifer recharge), but also from delivery of treated water, untreated surface water, and recycled water directly to users, which reduces groundwater extraction (called in-lieu recharge). Other direct and indirect benefits of the District's comprehensive groundwater management program include demand management, development of alternative water supplies, long-term water conservation, and protection of water quality.

A groundwater benefit zone includes any area within the District’s legal jurisdiction where any of the following criteria are met:

- A District activity provides water supply
- District activities improve groundwater supply reliability
- District activities prevent or limit land subsidence
- District activities reverse or control salt water intrusion
- District activities improve or maintain groundwater quality
- District activities improve groundwater levels

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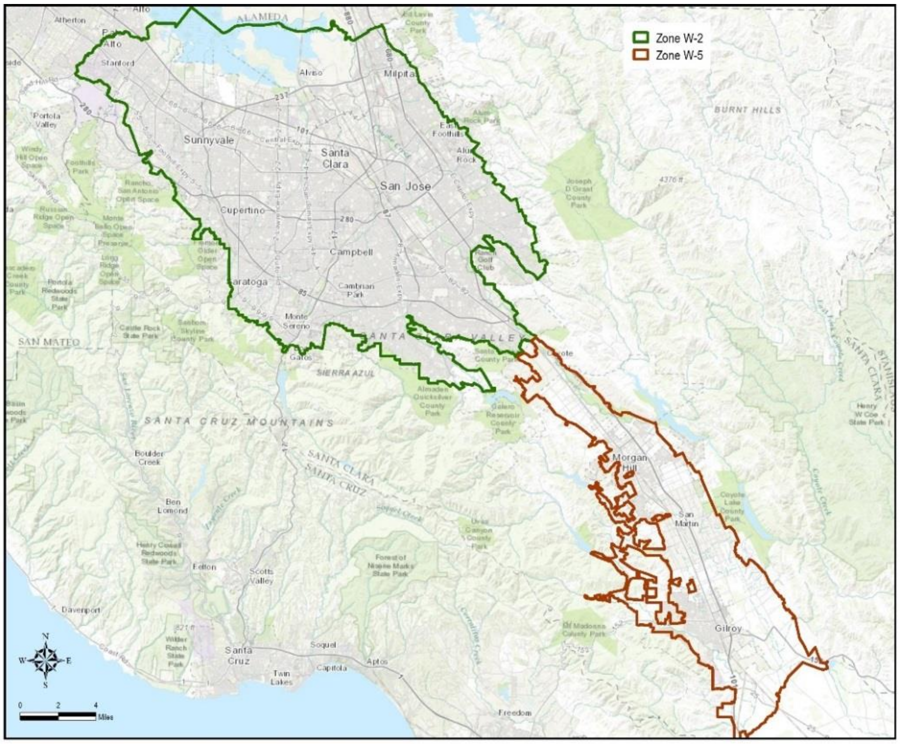


Figure ES- 1. Existing Groundwater Benefit Zones

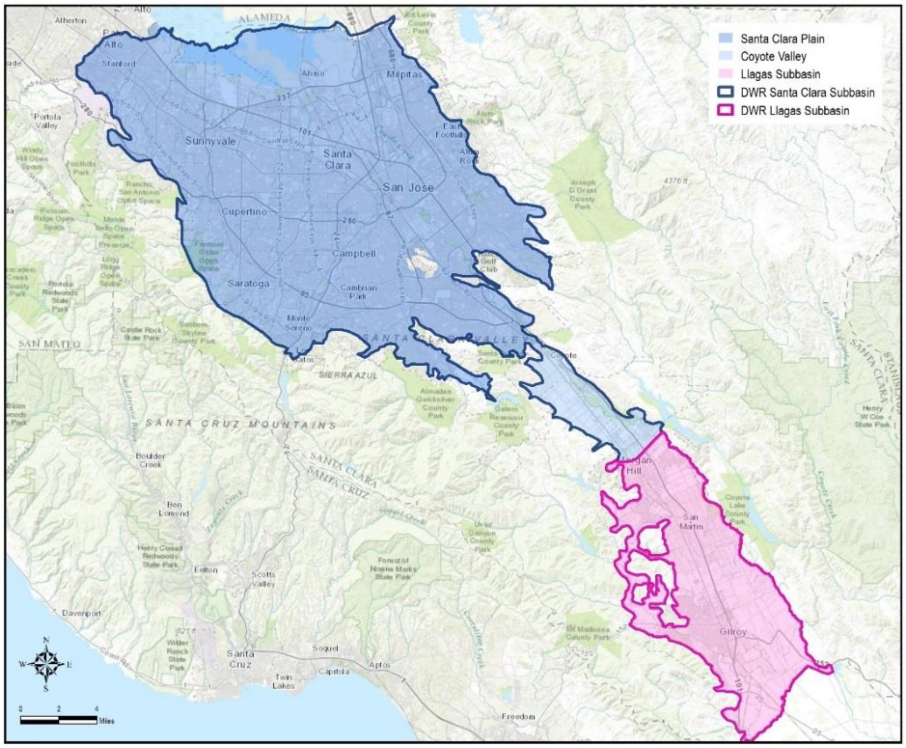


Figure ES- 2. DWR Bulletin 118 Subbasins and District Groundwater Management Areas

The Study is based on the premise that benefits from District activities extend throughout areas connected by groundwater flow (called hydrogeologically connected areas) that occurs in similar geologic deposits. The hydrogeologically connected areas are primarily defined by the geologic contact between alluvium (gravel, sand, silt, and clay sediments deposited by streams) in the valley floors and bedrock of the adjacent mountain ranges (Figure ES- 3 and Figure ES- 4). Groundwater generally flows through the alluvium until encountering bedrock or other hydrogeologic boundaries so continuous areas of alluvium are generally hydrogeologically connected. The hydrogeologic connection in bedrock is likely limited in spatial extent. Other hydrogeologic boundaries include groundwater divides between areas where groundwater flows in opposite directions, faults, areas where alluvium narrows and/or steepens, and contacts between alluvium formations with different levels of consolidation as narrower spaces between the alluvial sediments restrict groundwater flow. Geologic formations of alluvium that are candidates for hydrogeologically connected areas in the Study area include Unconsolidated Alluvium (alluvium) and the Santa Clara Formation (Figure ES- 4).

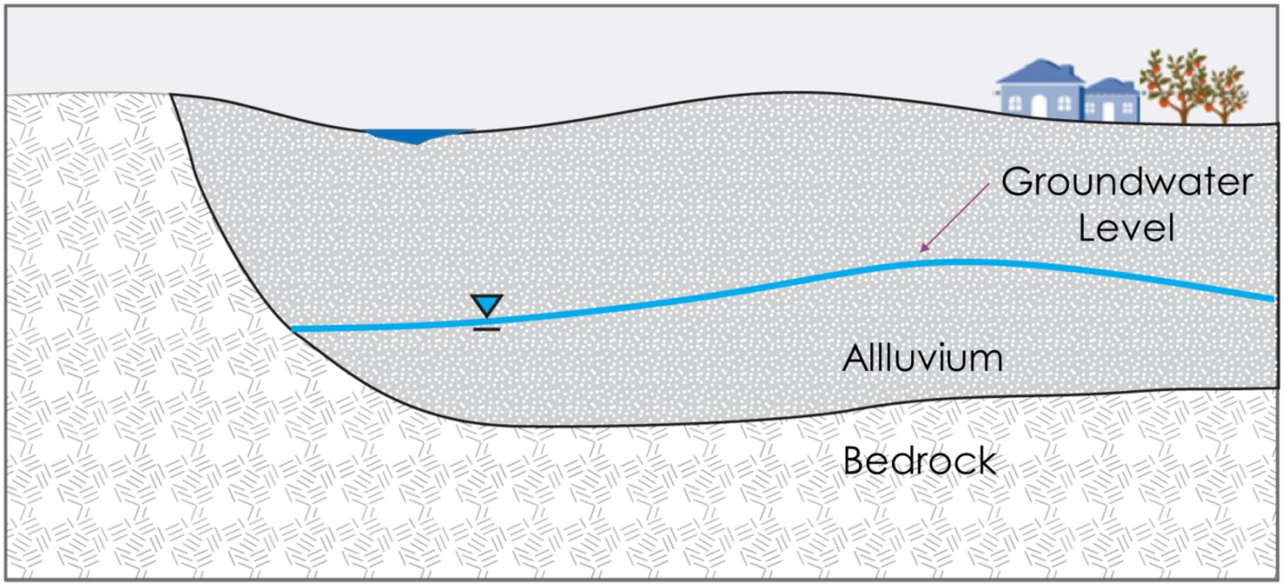
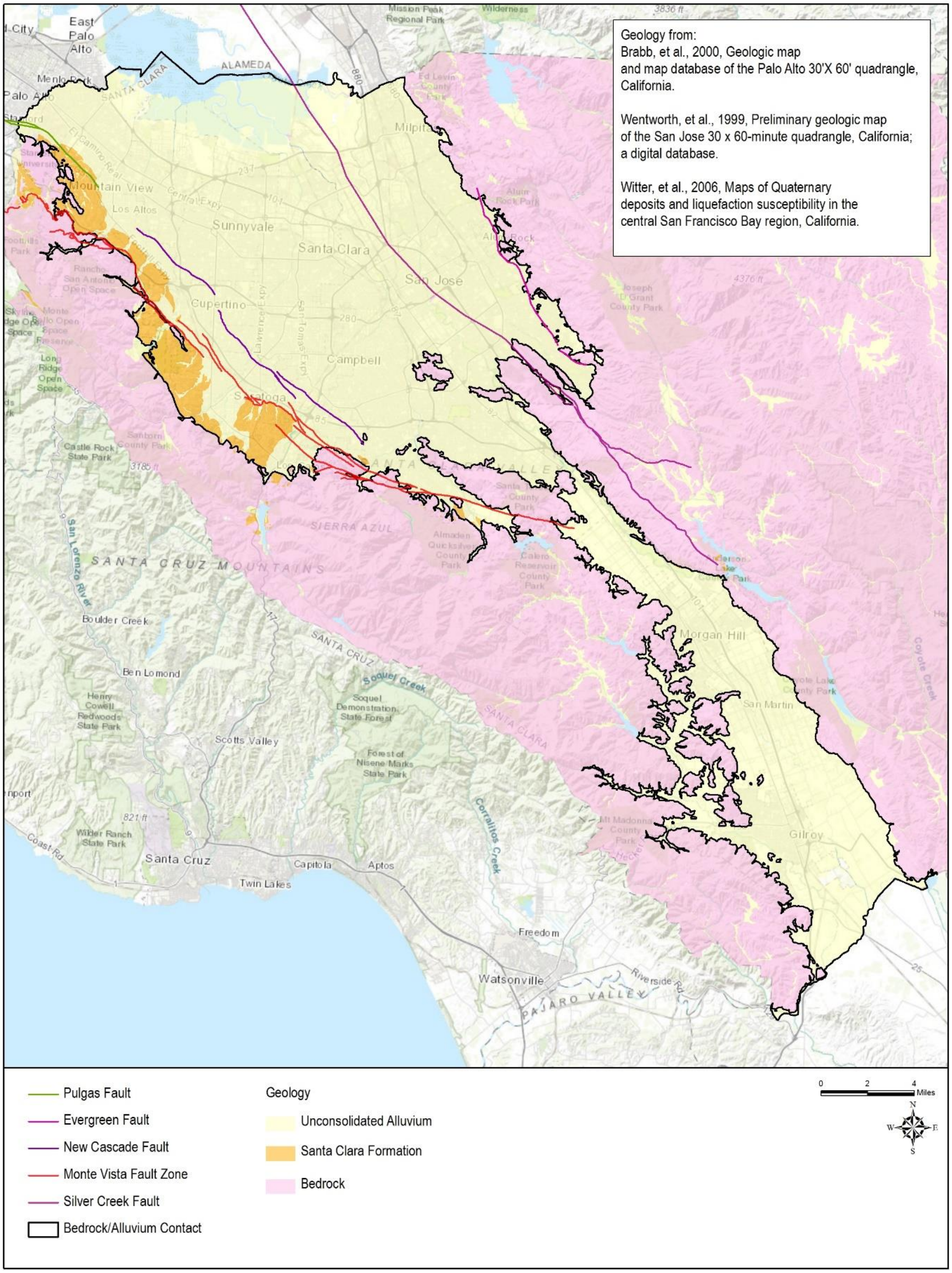


Figure ES- 3. Schematic Cross-Section of Alluvium and Bedrock



Geology from:
Brabb, et al., 2000, Geologic map and map database of the Palo Alto 30'X 60' quadrangle, California.

Wentworth, et al., 1999, Preliminary geologic map of the San Jose 30 x 60-minute quadrangle, California; a digital database.

Witter, et al., 2006, Maps of Quaternary deposits and liquefaction susceptibility in the central San Francisco Bay region, California.

Figure ES- 4. Geology of Santa Clara County

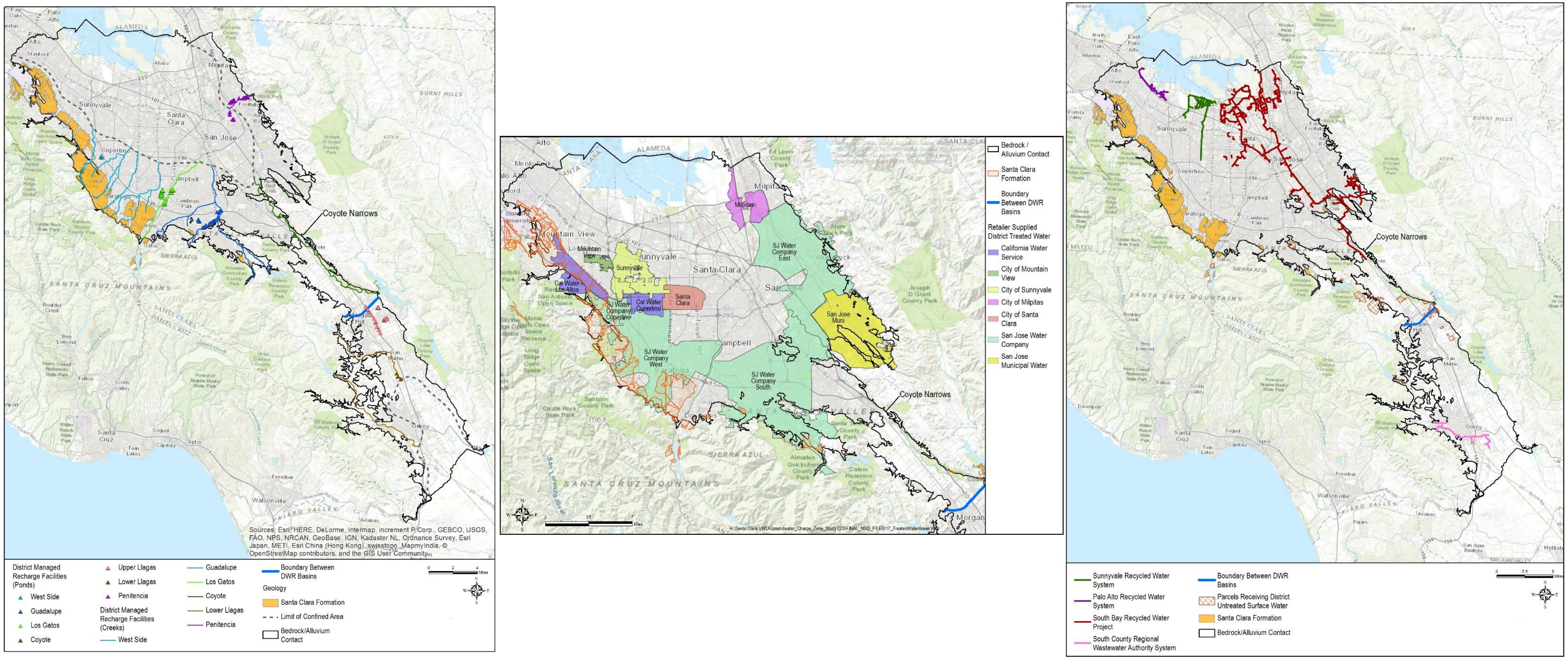
An evaluation of water budgets of the subbasins shows the benefits of District groundwater replenishment activities of managed recharge and in-lieu recharge. Without these groundwater replenishment activities, groundwater pumping would exceed recharge. By better balancing recharge and groundwater pumping, District activities improve groundwater levels, which provides benefits of improving groundwater supply reliability, limiting land subsidence, and controlling saltwater intrusion.

The Study uses historical data and numerical groundwater modeling to evaluate the extent of hydrogeologically connected areas benefiting from District activities (Figure ES- 5). If data and modeling are insufficient to assess whether an area benefits from one or more District activities, the Study uses assumptions about hydrogeologic connection within and between different alluvium and bedrock formations to evaluate where benefits extend from District activities.

The Study reaches the following conclusions that lead to the development of proposed groundwater benefit zones:

1. District recharge activities are located in alluvium that provides hydrogeologic connection throughout the Santa Clara and Llagas Subbasins.
2. District recharge activities have improved the water balance in hydrogeologically connected areas over time.
3. Groundwater level data and numerical groundwater modeling results demonstrate that benefits from District activities extend throughout hydrogeologically connected areas of Unconsolidated Alluvium where the District activities are located.
4. The groundwater level data do not conclusively demonstrate that benefits of District treated water deliveries in the Santa Clara Plain extend south into Coyote Valley as the Coyote Narrows may restrict groundwater flow between the two management areas.
5. Groundwater level data and modeling results are not available to evaluate whether benefits from District activities in the Unconsolidated Alluvium of the Santa Clara Plain extend into the Santa Clara Formation located on the west side of the Santa Clara Plain and there lacks information documenting a hydrogeological connection between the Santa Clara Formation and the Unconsolidated Alluvium.
6. District treated water delivery reduces groundwater demand in the Santa Clara Formation thereby improving the groundwater supply. The Santa Clara Formation consists of hydrogeologically connected alluvium. Therefore, District in-lieu recharge activities in the Santa Clara Formation benefit connected areas of the Santa Clara Formation. However, the uncertainty of this conclusion is higher than a similar conclusion for the Unconsolidated Alluvium due to lack of groundwater level data and numerical groundwater modeling.

7. Groundwater level data and modeling results are not available to evaluate whether benefits from District activities in alluvium (Unconsolidated Alluvium or Santa Clara Formation) extend into bedrock. However, bedrock areas receiving District treated water supplies benefit from in-lieu recharge to those areas that reduce groundwater pumping from bedrock fractures. However, bedrock fractures may be limited in areal extent, so the benefit is not considered to extend beyond the bedrock areas receiving District treated water.
8. Groundwater level data and modeling results are not available to demonstrate that managed recharge of imported water in the Llagas Subbasin valley floor benefits the narrow alluvium along Llagas and Uvas Creeks downstream of District reservoirs and upstream of the valley floor. However, the alluvium along these creeks does benefit from District releases of local runoff for managed recharge.



Managed Aquifer Recharge Facilities

Treated Water Delivery Areas (In-lieu Recharge)

Recycled Water Systems and Surface Water Delivery Parcels (In-lieu Recharge)

Figure ES- 5. Maps of District Activities

Based on the above conclusions, the Study proposes the following benefit zones as shown on Figure ES-6.

Zone A: Benefits from Managed Aquifer Recharge, Treated Water Deliveries, and Recycled Water Programs in the Santa Clara Plain - Zone A consists of areas overlying Unconsolidated Alluvium, and benefits from District treated water deliveries, managed aquifer recharge using local runoff and imported water, and recycled water programs. Zone A excludes areas of mapped Santa Clara Formation where benefits from managed aquifer recharge activities are not evaluated due to limited well data. The northern boundary is the San Mateo-Santa Clara County line and the southern boundary is the boundary between existing Zones W-2 and W-5.

Zone B1: Benefits from Treated Water Deliveries in the Santa Clara Formation - Zone B1 consists of areas within the Santa Clara Formation that are hydrogeologically connected to areas where District treated water is delivered. Data are not available to demonstrate benefits from the District's managed aquifer recharge. Foothill Expressway is used to approximate the eastern extent of the Santa Clara Formation underlying the alluvial outcrop. In addition to approximating this geological boundary, this also lines up with the District treated water delivery area for the Cal Water Los Altos service area; the treated water delivery provides in-lieu benefits for this area of the zone.

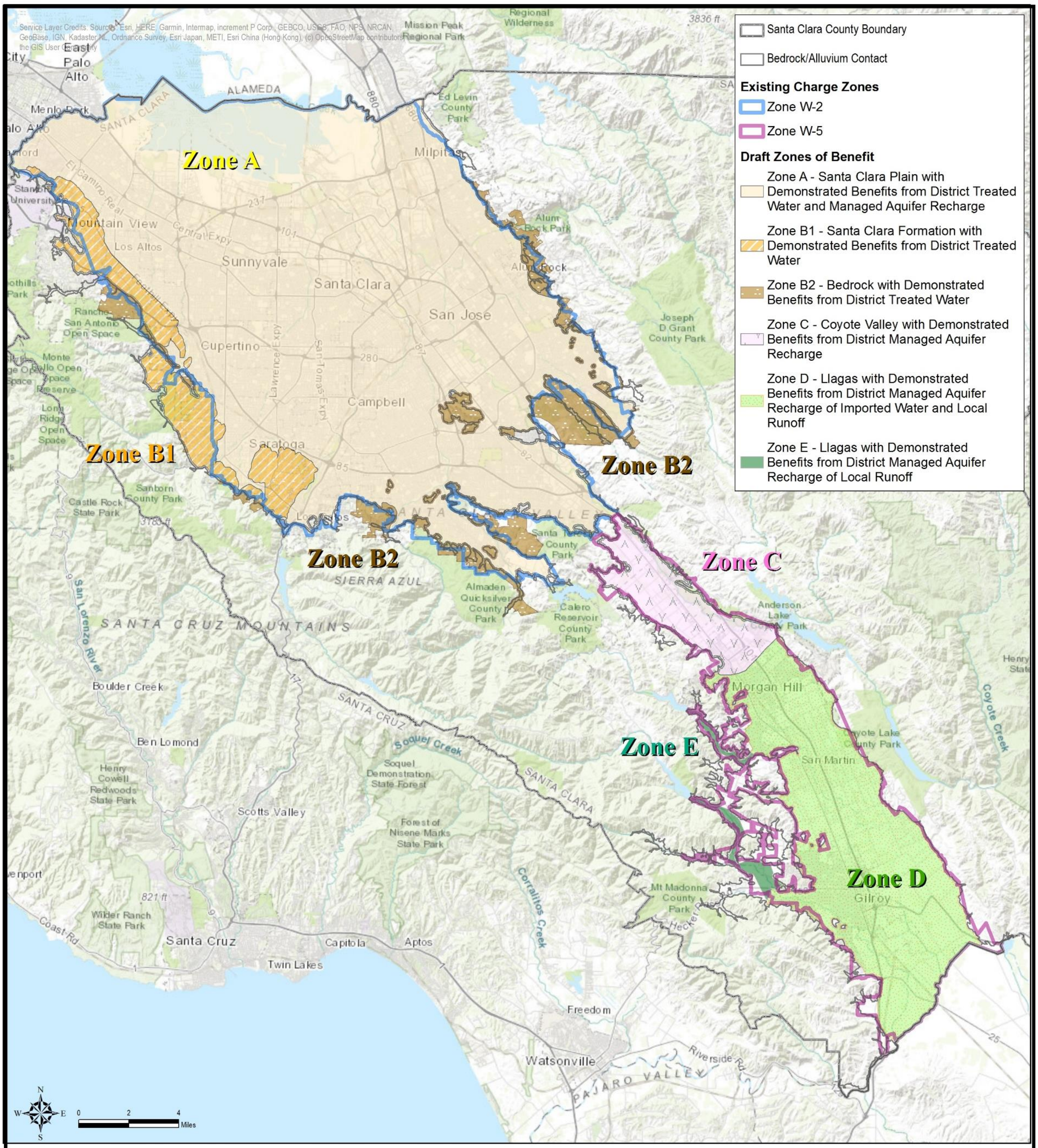
Zone B2: Benefits from Treated Water Deliveries in Bedrock - Zone B2 consists of areas with underlying bedrock where District treated water is delivered. Bedrock areas outside the treated water delivery areas are excluded from this and other zones because bedrock fractures with accessible groundwater may be limited in areal extent. Therefore, the benefit is not considered to extend beyond the treated water delivery area. Zone B2 includes many separate areas where bedrock underlies District treated water delivery areas.

Zone C: Benefits from Managed Aquifer Recharge in Coyote Valley - Zone C consists of Unconsolidated Alluvium in the Coyote Valley where benefits from managed aquifer recharge using both local runoff and imported water are demonstrated. The northern boundary is the boundary between existing Zones W-2 and W-5. The southern boundary is the boundary between the California Department of Water Resources (DWR) Santa Clara and Llagas Subbasins that approximates the groundwater divide separating the two basins.

Zone D: Benefits from Managed Aquifer Recharge (Local Runoff and Imported Water) and Recycled Water Programs in the Llagas Subbasin – Zone D consists of areas overlying Unconsolidated Alluvium in the Llagas Subbasin where benefits from managed aquifer recharge of imported and local water are demonstrated. The zone contains the entire retail service areas of the cities of Morgan Hill and Gilroy because groundwater pumped from areas where benefits are demonstrated are delivered to these hydrogeologically connected areas within Morgan Hill and Gilroy. The northern boundary is the boundary between the Santa Clara and Llagas

Subbasins as defined by DWR. The southern boundary is based on the Santa Clara-San Benito County line corresponding with the southern extent of Unconsolidated Alluvium in Santa Clara County.

Zone E: Benefits from Managed Aquifer Recharge of Local Runoff in Uvas/Llagas – Zone E consists of areas overlying Unconsolidated Alluvium along upper Uvas and Llagas Creeks where District managed aquifer recharge of local runoff occurs. This includes Unconsolidated Alluvium west of the cities of Morgan Hill and Gilroy that are deposited along Llagas Creek and Uvas Creek below the District's Chesbro and Uvas Reservoirs. These narrow alluvial channels are surrounded by bedrock outcrops and are upstream of the main valley floor. The boundary between proposed Zones D and E is based upon the location where data and groundwater model results are available to demonstrate benefit from imported water and the boundaries of retail service areas of the cities of Morgan Hill and Gilroy. Alluvial channels for tributaries that are not directly downstream of the District's reservoirs are excluded from this zone.


Santa Clara County Boundary
Bedrock/Alluvium Contact
Existing Charge Zones
Zone W-2
Zone W-5
Draft Zones of Benefit
Zone A - Santa Clara Plain with Demonstrated Benefits from District Treated Water and Managed Aquifer Recharge
Zone B1 - Santa Clara Formation with Demonstrated Benefits from District Treated Water
Zone B2 - Bedrock with Demonstrated Benefits from District Treated Water
Zone C - Coyote Valley with Demonstrated Benefits from District Managed Aquifer Recharge
Zone D - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Imported Water and Local Runoff
Zone E - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Local Runoff
Zone A
Zone B1
Zone B2
Zone B2
Zone C
Zone D
Zone E
Mountain View
Sunnyvale
Santa Clara
San Jose
Cupertino
Campbell
Saratoga
Los Gatos
Milpitas
Morgan Hill
San Martin
Gilroy
Santa Cruz
Scotts Valley
Watsonville
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These mapped zones may be revised further to account for administrative requirements. These zones will also require additional revision to facilitate the development of legal descriptions for the zones. This will involve approximating the boundaries to reduce the number of line segments that require a metes and bounds description.

Zone A: Benefits from Managed Aquifer Recharge, Treated Water Deliveries, and Recycled Water Programs in the Santa Clara Plain

Zone A consists of areas overlying Unconsolidated Alluvium, and benefits from District treated water deliveries, managed aquifer recharge using local runoff and imported water, and recycled water programs. Zone A excludes areas of mapped Santa Clara Formation where benefits from managed aquifer recharge activities are not evaluated due to limited well data. The northern boundary is the San Mateo-Santa Clara County line and the southern boundary is the boundary between existing Zones W-2 and W-5.

Zone B1: Benefits from Treated Water Deliveries in the Santa Clara Formation

Zone B1 consists of areas within the Santa Clara Formation that are hydrogeologically connected to areas where District treated water is delivered. Data are not available to demonstrate benefits from the District's managed aquifer recharge. Foothill Expressway is used to approximate the eastern extent of the Santa Clara Formation underlying the alluvial outcrop. In addition to approximating this geological boundary, this also lines up with the District treated water delivery area for the Cal Water Los Altos service area; the treated water delivery provides in-lieu benefits for this area of the zone.

Zone B2: Benefits from Treated Water Deliveries in Bedrock

Zone B2 consists of areas with underlying bedrock where District treated water is delivered. Bedrock areas outside the treated water delivery areas are excluded from this and other zones because bedrock fractures with accessible groundwater may be limited in areal extent. Therefore, the benefit is not considered to extend beyond the treated water delivery area. Zone B2 includes many separate areas where bedrock underlies District treated water delivery areas.

All zones benefit from long-term water conservation and groundwater protection activities

Zone C: Benefits from Managed Aquifer Recharge in Coyote Valley

Zone C consists of Unconsolidated Alluvium in the Coyote Valley where benefits from managed aquifer recharge using both local runoff and imported water are demonstrated. The northern boundary is the boundary between existing Zones W-2 and W-5. The southern boundary is the boundary between the California Department of Water Resources (DWR) Santa Clara and Llagas subbasins that approximates the groundwater divide separating the two basins.

Zone D: Benefits from Managed Aquifer Recharge (Local Runoff and Imported Water) and Recycled Water Programs in the Llagas Subbasin

This zone consists of areas overlying Unconsolidated Alluvium in the Llagas Subbasin where benefits from managed aquifer recharge of imported and local water are demonstrated. The zone contains the entire retail service areas of the cities of Morgan Hill and Gilroy. The northern boundary is the boundary between the Santa Clara and Llagas subbasins as defined by DWR. The southern boundary is based on the Santa Clara-San Benito County line corresponding with the southern extent of

Zone E: Benefits from Managed Aquifer Recharge of Local Runoff in Uvas/Llagas Creek Bottoms

This zone consists of areas overlying Unconsolidated Alluvium along upper Uvas and Llagas creeks where District managed aquifer recharge of local runoff occurs. This includes Unconsolidated Alluvium west of the cities of Morgan Hill and Gilroy that are deposited along Llagas Creek and Uvas Creek below the District's Chesbro and Uvas Reservoirs. These narrow alluvial channels are surrounded by bedrock outcrops and are upstream of the main valley floor. The boundary between proposed Zones D and E is based upon the location where data and groundwater model results are available to demonstrate benefit from imported water. Alluvial channels for tributaries that are not directly downstream of the District's reservoirs are excluded from this zone.

H:\Santa Clara VWD\Groundwater_Charge_Zone_Study\GIS\FINAL_MXD_FILES\zoneMAPS\ZOB_figures\3_Draft_Zones_of_Benefit.mxd

Figure ES-6. Proposed Groundwater Benefit Zones

The Study recommends an increase in zones from two to six to associate zones with benefits from specific activities. However, the recommended zones are a result of a technical analysis that does not consider the related administrative issues or requirements for revised zones or increased number of zones. Any changes to the zones must be approved by the District Board of Directors, who will consider all related issues.

The geologic coverage boundaries are based on spatial interpretation and include uncertainty. The proposed zones are based solely on geologic coverages consisting of many connected lines, which would be unnecessarily expensive to describe with metes and bounds, as required by the District Act. It is justified to simplify boundaries to approximate geologic boundaries and reduce the number of lines for the legal descriptions. Therefore, zone boundaries have been simplified for Board consideration in advance of creating legal descriptions with metes and bounds if directed by the Board. In addition to simplifying the boundaries, zone boundaries at geologic boundaries have been adjusted to account for the uncertainty of those boundaries.

The Study also includes proposed processes for well exemptions from the groundwater benefit zones and future reviews of the groundwater benefit zones. Well exemptions are recommended to be evaluated based on well owner requests and on geology documented by the well log and other sources. Future reviews are recommended if the District substantially changes the activities that provide benefits or significant new hydrogeologic data become available.

2 BACKGROUND AND SCOPE

2.1 Groundwater Benefit Zones

The Santa Clara Valley Water District (District) Act gives the District Board of Directors the authority to establish, amend, and revise groundwater benefit zones (District Act Section 3), and to levy and collect groundwater charges within a zone or zones that benefit from the recharge of underground water supplies or the distribution of imported water (District Act Section 26). The two primary existing groundwater benefit zones, Zones W-2 and W-5, were established in 1963 and 1977, respectively. Zone W-2 generally covers the Santa Clara Plain in North County while Zone W-5 generally covers the Coyote Valley and Llagas Subbasin in South County (Figure 1).

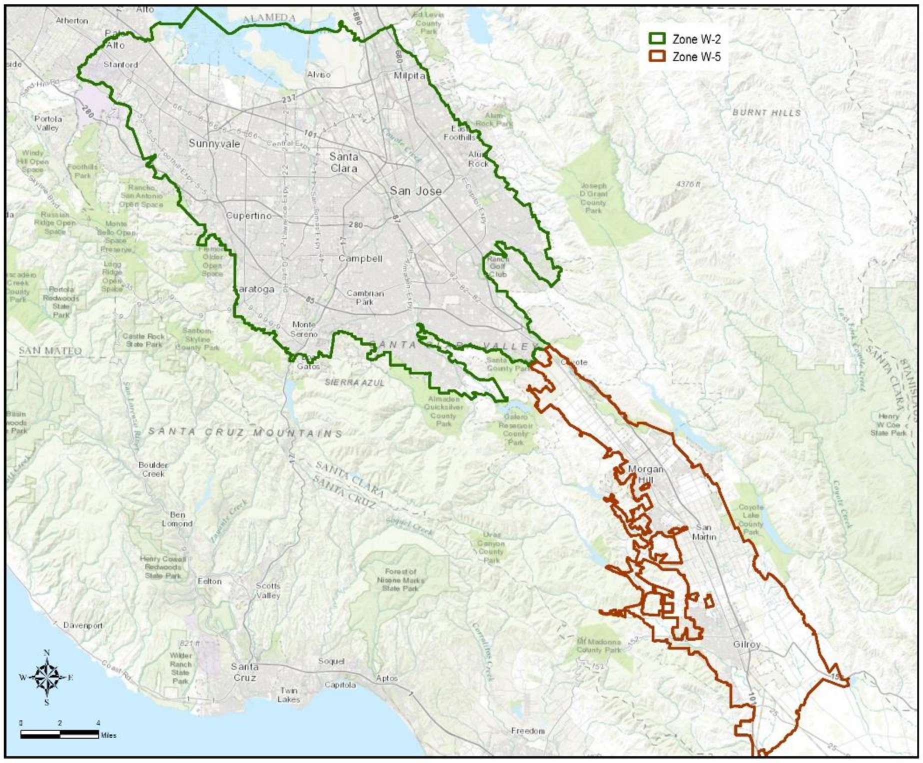


Figure 1. Existing Groundwater Benefit Zones

Figure 2 shows the three groundwater management areas of the District: the Santa Clara Plain, Coyote Valley, and Llagas Subbasin, along with the California Department of Water Resources (DWR) subbasin boundaries. Coyote Valley is part of District Zone W-5, but DWR includes Coyote Valley as part of the Santa Clara Subbasin.

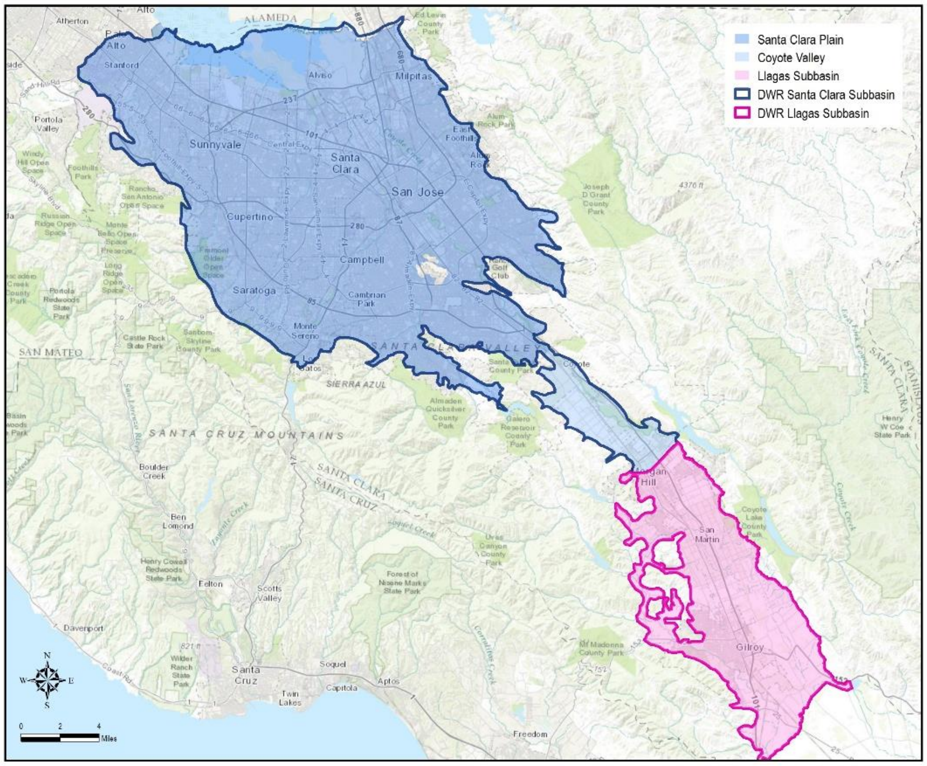


Figure 2. DWR Bulletin 118 Subbasins and District Groundwater Management Areas

The purpose of the Groundwater Benefit Zone Study (Study) is to complete a comprehensive review of the groundwater benefit zones to ensure they reflect areas where groundwater users receive similar benefits from current and planned District activities. Although the District is not aware of any specific problems with the existing groundwater benefit zone designations, the District has received requests for exemptions and recognizes that it is important for the District to periodically undertake an updated analysis of various factors upon which the zones are based, and revise the boundaries if necessary. The Study evaluates the ways in which the various District activities benefit groundwater users. These benefits are derived not only from the conjunctive use of surface water supplies for direct groundwater recharge, but also include the direct and indirect benefits of the District's comprehensive groundwater management, including in-lieu recharge, demand management, development of alternative water supplies, long-term conservation, and protection of water quality, amongst others.

2.2 History of District and Groundwater Benefits

The District has provided groundwater benefits to Santa Clara County for approximately ninety years. In 1929, county voters approved the formation of the Santa Clara Valley Water Conservation District (SCVWCD), the forerunner to the District, in order to stop groundwater overdraft and subsidence. Today’s District was formed through the consolidation and annexation of multiple flood control and water districts within Santa Clara County. From 1935 to 1957, District forerunners constructed dams to capture surface water runoff for groundwater recharge. This period coincided with a period of recovery in groundwater levels that reduced the rate of land subsidence from the late 1930s to 1947 (SCVWD, 2016b).

Drought conditions beginning in 1947 resulted in rapidly declining groundwater levels and a resumption of subsidence and by 1950, groundwater met almost all of the county's water demand. Despite delivery by San Francisco Public Utilities Commission (SFPUC) of imported water to northern Santa Clara County in the 1950s, groundwater pumping increased resulting in further groundwater declines as the county's population doubled from 1950 to 1960. As the area's water demands exceeded the combination of SFPUC imported water and local water supplies, the District contracted with the State Water Project to receive imported water through the South Bay Aqueduct (SCVWD, 2016b).

Having this source of imported water allowed the District to deliver treated surface water to North County residents, which offset the need for groundwater pumping in the Santa Clara Plain and led to recovery of groundwater levels and reduced rate of subsidence. Deliveries of SFPUC imported water also increased in the 1960s contributing to these water budget improvements. By the mid-1980s, the county's population had more than doubled from 1960, but groundwater pumping was down to half of total water use and rate of inelastic land subsidence was reduced approximately 99%. The District contracted with the federal government for additional source of imported supply from the Central Valley Project in 1987 to continue providing groundwater benefits as the economy and population continued to grow (SCVWD, 2016b).

In the 1990s, the District supported expansion of recycled water use to reduce the demand on groundwater. The construction and operation of the District's Silicon Valley Advanced Water Purification Center beginning in 2014 that delivers purified water that is a result of treating tertiary- treated recycled water with microfiltration, reverse osmosis, and ultraviolet light. This additional source of water supply provides current and future benefits by reducing the demand on groundwater and may also be a source for future recharge of groundwater (SCVWD, 2016b).

The District responded to the 1976-1977 drought by implementing its first conservation programs, expanded the efforts during the 1987-1992 drought, and continues with enhancements to these programs to provide groundwater benefits by reducing groundwater demand.

The District has identified groundwater contamination as a significant issue for the resource beginning in the 1980s. The District has since developed multiple programs to protect groundwater quality in the subbasins.

2.3 Summary of Methodology

HydroMetrics WRI, now Montgomery & Associates, developed the methodology for the Study and documented it in the Methodology for Evaluating Groundwater Zones of Benefit, Santa Clara County, California (HydroMetrics WRI, 2016). The District presented draft versions of the methodology to stakeholder groups including at a community open house, a small group briefing, and two meetings with District retailers. A Technical Review Committee (TRC) also provided review of the methodology. Appendix A provides the methodology document and Appendix B provides the stakeholder and TAC comments, and responses to those comments. Implementation of the Study required minor revisions to the methodology based on data availability, including:

- The Study uses pumping in a retailer area to account for in-lieu supplies other than the District activity instead of net demand;
- The Study evaluates periods when the District activity is active and constant instead of just periods when the District activity is increasing; and
- The Study evaluates groundwater levels by retailer area instead of at each well.

A groundwater benefit zone includes any area within the District's legal jurisdiction where any of the following criteria are met:

- A District activity provides water supply
- District activities improve groundwater supply reliability
- District activities improve groundwater levels
- District activities prevent or limit land subsidence
- District activities reverse or control salt water intrusion
- District activities improve or maintain groundwater quality

The Study uses historical groundwater level, subsidence, salt water intrusion, and groundwater quality data and groundwater flow modeling where available to assess the extent of areas benefitting from one or more District activities. The periods over which data and modeling can be evaluated for benefits are limited so the Study evaluates historical water budgets to assess whether benefits demonstrated in any time period can be applied to other periods.

If data and modeling are insufficient to assess whether an area benefits from District activities, the following assumptions are made:

- Benefits from a District activity extend to all areas that are connected by groundwater flow (hydrogeologically connected) to the activity.
- Areas with groundwater supplies that receive in lieu supplies from the District benefit from that District activity.

Evaluating groundwater benefit zones is based on the hydrogeological characteristics that govern the movement of groundwater, District activities, and the benefits to groundwater users provided by the activities. The Study follows the steps below:

1. Map an overview of benefits from District activities such as halting subsidence and reversing salt water intrusion that may require additional evaluation to associate benefits to specific sets of District activities.
2. Map hydrogeologic features and groundwater occurrence and movement to define hydrogeologically connected areas.
3. Plot water budget of pumping, managed recharge and in-lieu recharge over time in hydrogeologically connected areas to assess where the benefit of District activities can be demonstrated.
4. Map current and planned District activities that provide or will provide benefits to groundwater users in the District.
5. Use groundwater data and groundwater flow models where available to demonstrate the extent of benefit of District activities.
6. Create recommended groundwater benefit zones by grouping areas where users benefit from a specific set of District activities.

In implementing the methodology, the Study considers the following information:

- Geologic maps
- Geologic descriptions
- Groundwater level contour maps
- Fault maps
- Estimates of stratigraphic thickness
- Surface elevation
- Groundwater pumping quantities by area
- District managed aquifer recharge quantities by subbasin
- District treated water delivery quantities by subbasin

- District surface water delivery quantities by subbasin
- District supported recycled water delivery quantities by subbasin
- Conservation rebate locations
- Area precipitation
- Population changes
- Start dates of District activities
- Locations of District managed recharge activities
- Delivery areas of District and District supported in-lieu recharge activities
- Availability of non-District water supplies
- Groundwater level data
- Groundwater quality data
- Well locations
- Groundwater model simulation results

3 OVERVIEW OF DISTRICT ACTIVITIES

3.1 District Act

Section 3 of the District Act empowers the District Board to establish groundwater benefit zones. Section 26 describes the District activities that provide benefits. These District activities include:

- Groundwater recharge,
- Importing water,
- Runoff capture,
- Water storage,
- Water treatment,
- Water distribution,
- Water recycling,
- Groundwater protection, and
- Water conservation.

The primary benefits to groundwater users are derived from District activities that support some form of groundwater replenishment. Groundwater replenishment can be classified as managed aquifer recharge and in-lieu recharge, each of which involves some combination of the above activities, and are described further below. Groundwater replenishment provides benefits to maintain a reliable water supply, reduce risk of permanent land subsidence, and improve groundwater quality, as summarized in Section 4. By maintaining groundwater levels, groundwater replenishment also reduces pumping costs to well users.

Groundwater protection activities provide benefits to groundwater quality independently of groundwater recharge activities and maintaining groundwater quality is a key component of maintaining groundwater supply reliability. As further detailed in Section 4.4, these activities provide benefits to improve the reliability of the groundwater supply to meet drinking water standards, irrigation quality requirements, and quality needs of other uses.

3.2 Managed Aquifer Recharge Activities

Managed aquifer recharge improves groundwater conditions by supplementing natural recharge of the underlying aquifers with both local surface runoff and imported water. Natural recharge is insufficient to support groundwater pumping in the subbasins. How adding managed aquifer recharge balances groundwater pumping is further described in Section 6.2. By helping balance groundwater pumping, managed aquifer recharge provides benefits of improving groundwater levels thereby potentially improving groundwater supply reliability, preventing or limiting subsidence, and reversing or controlling salt water intrusion. Managed aquifer recharge can also improve groundwater quality. Activities that support managed aquifer recharge are shown in Figure 3.

The Study focuses on evaluating benefits from current activities related to managed aquifer recharge because historical groundwater data are available and show conditions with these activities. Facilities that make up these activities include surface water reservoirs, pipelines, canals, pumping stations, recharge ponds, and recharge creeks. The Study differentiates between systems that can recharge both local runoff and imported water and systems that can recharge only local runoff because imported water is a distinct District activity with different costs. Groundwater users that benefit only from managed aquifer recharge systems that can recharge only local runoff do not benefit from managed recharge of imported water.

Planned indirect potable reuse involves managed aquifer recharge of purified water. Purified water produced by the Silicon Valley Advanced Water Purification Center (SVAWPC) with advanced oxidation meets or exceeds all California drinking water standards, including all potable reuse regulations for groundwater replenishment.

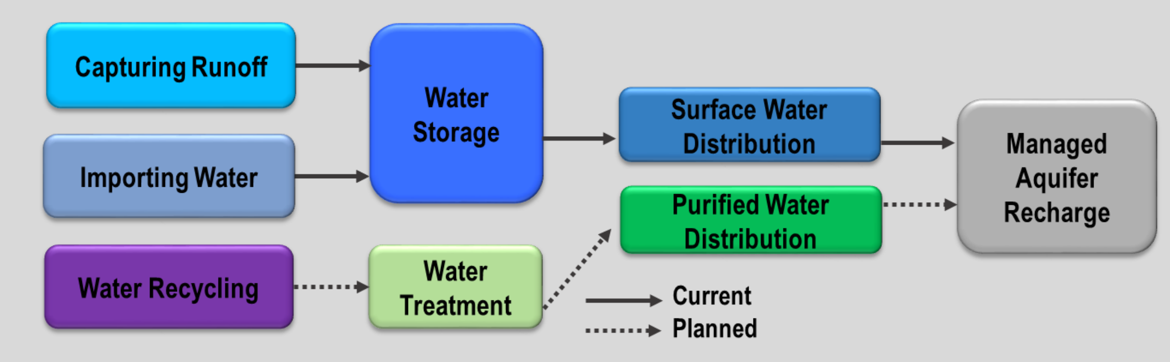


Figure 3. District Activities Supporting Managed Aquifer Recharge For Benefit of Groundwater Users

3.3 In-Lieu Recharge Activities

The District's direct delivery of water through various combinations of District activities, as shown in Figure 4, improves groundwater conditions by reducing groundwater extraction; this is referred to as in-lieu recharge. Demand management through water conservation programs also constitutes in-lieu recharge. Current groundwater pumping exceeds natural recharge, but without in-lieu recharge, groundwater pumping would also far exceed natural recharge and managed aquifer recharge combined, as further described in Section 0. By reducing groundwater pumping, in-lieu recharge provides benefits of improving groundwater levels thereby potentially improving groundwater supply reliability, preventing or limiting subsidence, and reversing or controlling salt water intrusion. Activities that support in-lieu recharge are shown in Figure 4.

The Study focuses on evaluating benefits from current activities related to treated water distribution because it is the largest type of in-lieu recharge provided by the District and historical groundwater data are available and they show conditions with these activities. Facilities that support treated water distribution include surface water reservoirs, canals, pump stations, treatment plants, and distribution pipelines.

The Study also evaluates recycled water distribution supported by the District and untreated surface water distribution by the District that provides in-lieu recharge.

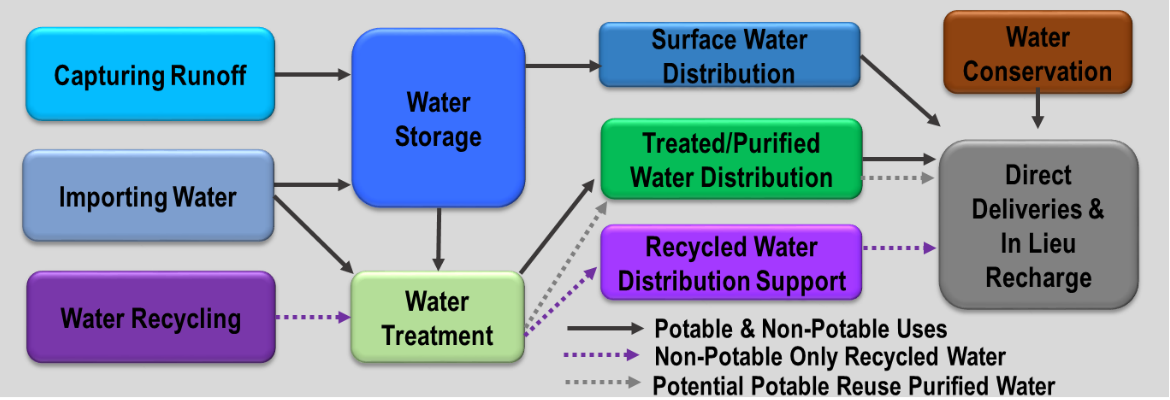

Capturing Runoff
Importing Water
Water Recycling
Water Storage
Water Treatment
Surface Water Distribution
Treated/Purified Water Distribution
Recycled Water Distribution Support
Water Conservation
Direct Deliveries & In Lieu Recharge
Potable & Non-Potable Uses
Non-Potable Only Recycled Water
Potential Potable Reuse Purified Water

Figure 4. District Activities Supporting In-Lieu Recharge for Benefit of Groundwater Users

3.4 Groundwater Protection Activities

Additional benefits are derived from the District’s groundwater protection programs, which improve groundwater conditions by maintaining or improving groundwater quality. Protecting groundwater quality is inextricably linked to water supply reliability as groundwater with impaired quality will not be able to meet the uses of water supply. The District’s groundwater protection activities include the following programs (SCVWD, 2016b):

- A free domestic well testing program for nitrates, which is offered to private well owners to help owners understand their water quality.
- Salt and nutrient management focused on reducing exposure to high nitrate concentrations, reducing additional nitrate and salt loading, managing nitrates and total dissolved solids (TDS) in groundwater, and monitoring salt and nutrient concentrations.
- Vulnerability assessments evaluating groundwater contamination risks.

- Coordination with land use agencies involving review of local land use plans, policies, and regulations in order to manage increased potential for groundwater contamination.
- Coordination with regulatory agencies to manage sites that pose a risk for releases of groundwater contaminants.
- Public outreach to educate the public on protecting the groundwater resource.

4 OVERVIEW OF BENEFITS FROM DISTRICT ACTIVITIES

Groundwater is a shared resource that can be represented by a water budget, which includes estimates of groundwater inflows (recharge) and outflows (pumping) and conjunctive use of surface water supplies within a given area. Improved groundwater conditions resulting from District groundwater management activities can be demonstrated by an improved water budget, i.e. groundwater conditions would be worse in the absence of District activities. An improved water budget represents the overall benefit of District managed aquifer recharge and in-lieu recharge activities that sustain an area's groundwater supply. As an example, District activities in calendar year 2013 resulted in 96,000 acre-feet of managed aquifer recharge by the District and 148,000 acre-feet of in-lieu recharge (treated water deliveries by the District and recycled water deliveries supported by the District) compared to 39,000 acre-feet of natural recharge (SCVWD, 2014). In addition, the District's conservation activities save approximately 64,000 acre-feet per year, based on 2015 estimates (SCVWD, 2016). District activities that result in an improved water budget provide the following benefits to groundwater users.

4.1 Improved Groundwater Supply Reliability

On average, groundwater accounts for 40% of the water used in Santa Clara County. Groundwater pumping (approximately 150,000 acre-feet in 2013) far exceeds natural recharge, and the District's managed and in-lieu recharge programs, including sustained and expanded conservation efforts, help replenish and sustain groundwater supplies. Figure 5 shows the rapidly growing population of Santa Clara County after World War II that was supported by a groundwater supply improved by District activities. This groundwater supply also supports high rates of business development and a viable agricultural economy. Community growth, quality of life and economic prosperity depend on a reliable and sustainable water supply that can be attributed to District groundwater management activities.

The Study uses historical groundwater level data and model results to evaluate improved groundwater supply reliability related to District activities.

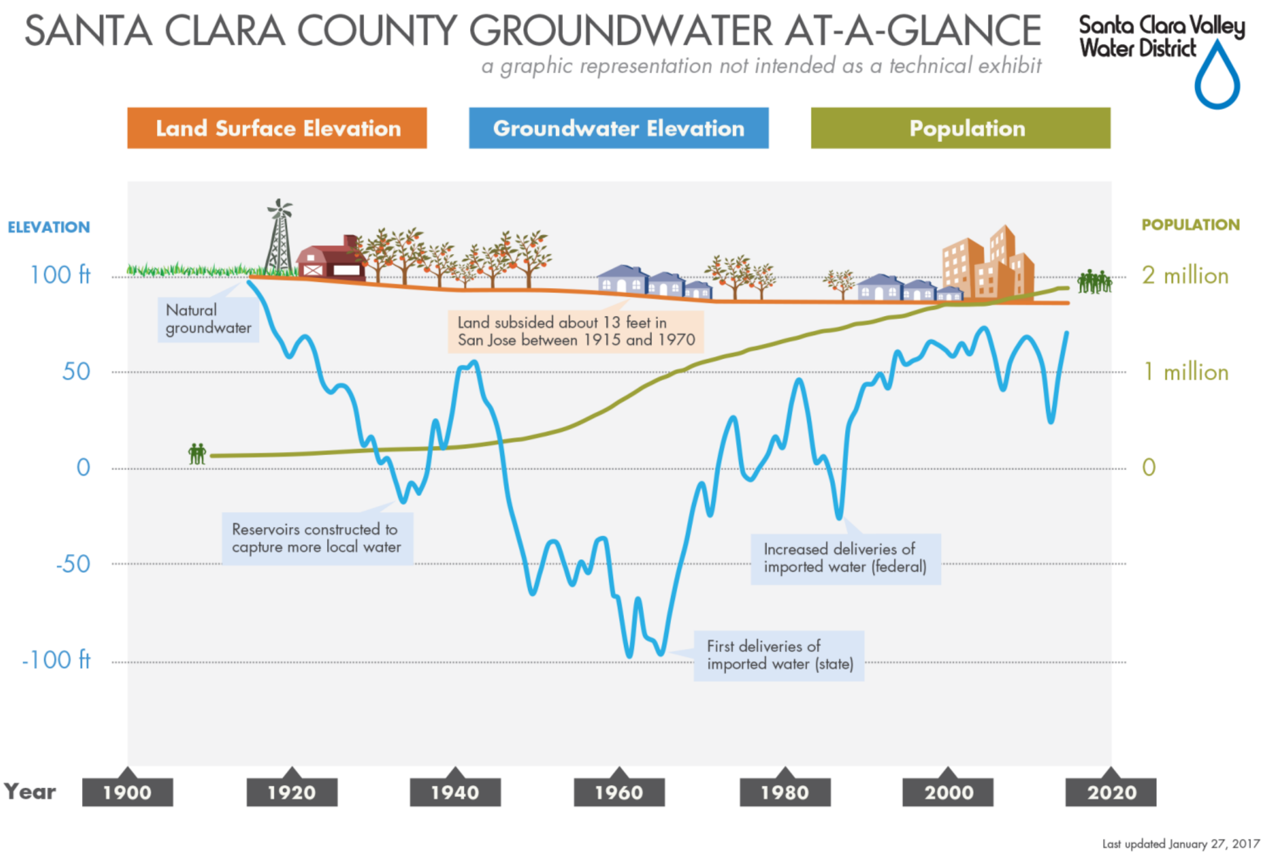
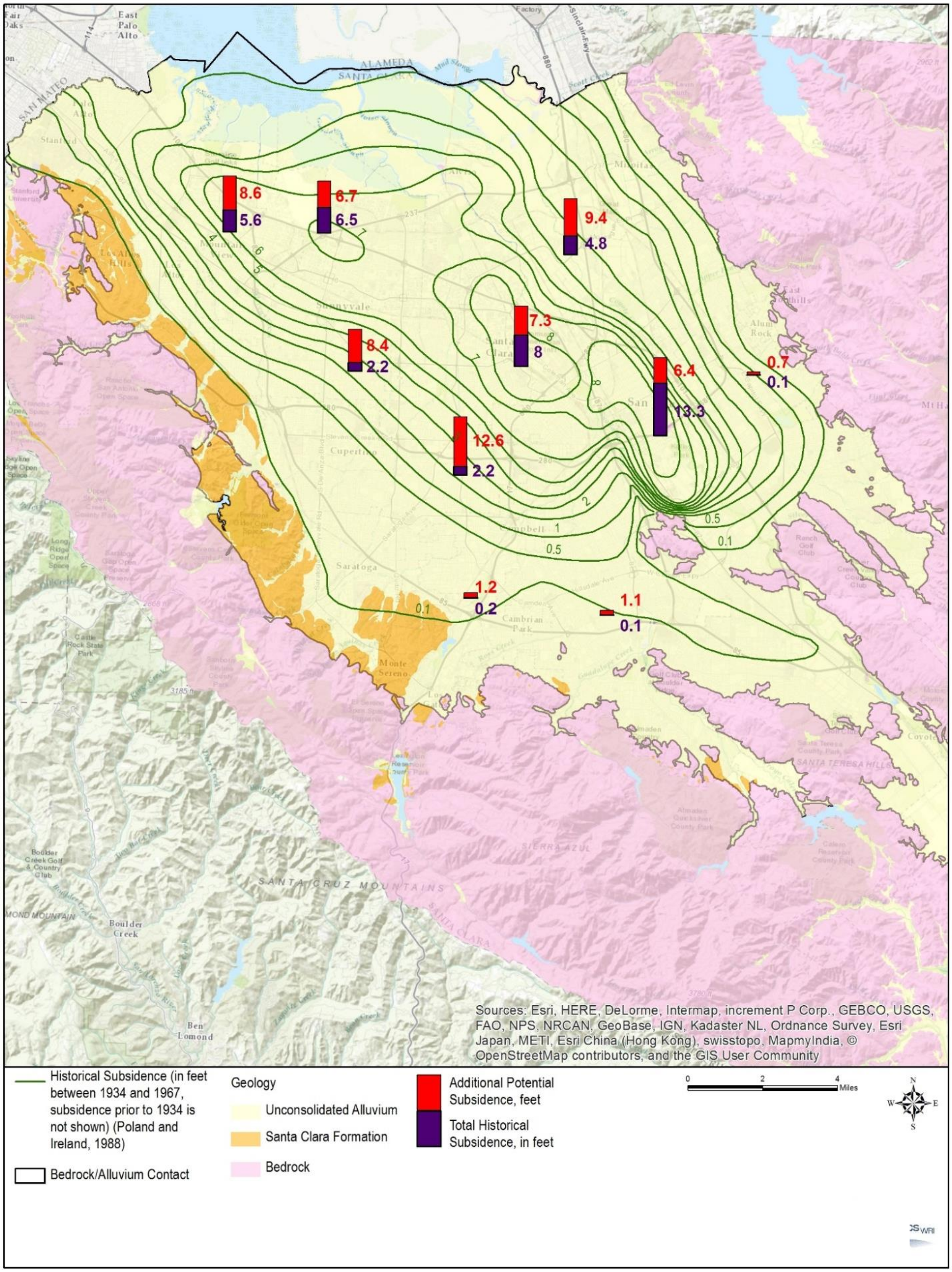


Figure 5. Graphic Representation of Groundwater Levels, Population and Land Subsidence (Courtesy SCVWD)

4.2 Reduced Risk of Land Subsidence

As shown in Figure 5 portions of the Santa Clara Valley subsided approximately 13 feet between 1915 and 1970 when groundwater pumping generally exceeded total recharge. During that time, there was at least a 1-foot drop in the land surface over a 100-square mile area including portions of Palo Alto, Mountain View, Sunnyvale, Santa Clara, and San Jose (Figure 6). Since then, permanent inelastic subsidence has been halted due to an improved water budget resulting from District activities (SCVWD, 2016). Subsidence can result in adverse effects such as damaged infrastructure, increased flooding risk, increased sediment erosion or deposition, and, where relevant, impairment of leveled agricultural fields. Therefore, preventing subsidence is a benefit of the improved water budget resulting from District activities.

Figure 5 represents subsidence at one location (downtown San Jose) over time, but subsidence data over time at multiple locations are necessary to evaluate benefits over a broader area. Maps of subsidence are available only at specific times (Figure 6). Figure 6 also shows subsidence measured at extensometers, which shows subsidence halted before maximum subsidence could occur. Figure 6 shows the area where District activities provide the benefit of preventing subsidence. While it is clear that District activities have contributed to preventing subsidence and therefore support the area being part of a benefit zone, additional evaluation is required to associate the subsidence benefits to specific sets of District activities and account for other sources of recharge such as rainfall or in-lieu supplies of surface water from San Francisco Public Utilities Commission (SFPUC) Regional Water System (RWS). This additional evaluation may show that the subsidence benefits result from different District activities in different areas which would support defining multiple groundwater benefit zones for the area of subsidence benefits. As shown in Figure 5, raising groundwater elevations prevents subsidence so the Study uses historical groundwater level data and model results to evaluate benefits of preventing subsidence related to District activities.


8.6
5.6
6.7
6.5
9.4
4.8
7.3
8
8.4
2.2
6.4
13.3
0.7
0.1
12.6
2.2
1.2
0.2
1.1
0.1
0.5
0.1
2
1
0.5
0.1
Historical Subsidence (in feet between 1934 and 1967, subsidence prior to 1934 is not shown) (Poland and Ireland, 1988)
Bedrock/Alluvium Contact
Geology
Unconsolidated Alluvium
Santa Clara Formation
Bedrock
Additional Potential Subsidence, feet
Total Historical Subsidence, in feet
0
2
4
Miles
N
W
E
S

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 6. Subsidence Contours with GeologySalt Water Intrusion Prevention

4.3 Salt Water Intrusion Prevention

Historically, denser salt water moved inland via creeks connected to the San Francisco Bay then infiltrated groundwater when groundwater pumping exceeded natural recharge and subsidence resulted in greater tidal influence on the creeks connected to the bay (SCVWD, 2016b). Figure 7 shows the inland migration of salt water in the shallow aquifer zone from 1945 to 1980. Figure 7 additionally illustrates the reversal of salt water intrusion in the shallow zone from 1980 to 2015. Although salt water intrusion has been observed only in a small portion of the deeper aquifer zone that provides groundwater supply (SCVWD, 2016), salt water intrusion would represent a risk to the groundwater quality of the deeper groundwater supply due to potential for inter-aquifer transfer through improperly destroyed wells or other borings. Reducing this risk to groundwater quality improves the reliability of groundwater supply. Therefore, preventing salt water intrusion is a benefit of the improved water budget from District activities.

Maps of salt water intrusion are available only at the specific times shown on Figure 7. This figure shows areas where District activities provide the benefit of reducing salt water intrusion. Both managed aquifer recharge and treated water deliveries have helped raise groundwater levels in areas subject to saltwater intrusion; however, additional evaluation is required to associate those benefits to specific sets of District activities and account for other sources of recharge such as rainfall or in-lieu supplies of water from SFPUC RWS. Raising groundwater elevations is the mechanism for reducing salt water intrusion so the Study uses historical groundwater level data and model results to evaluate benefits of reducing saltwater intrusion related to District activities.

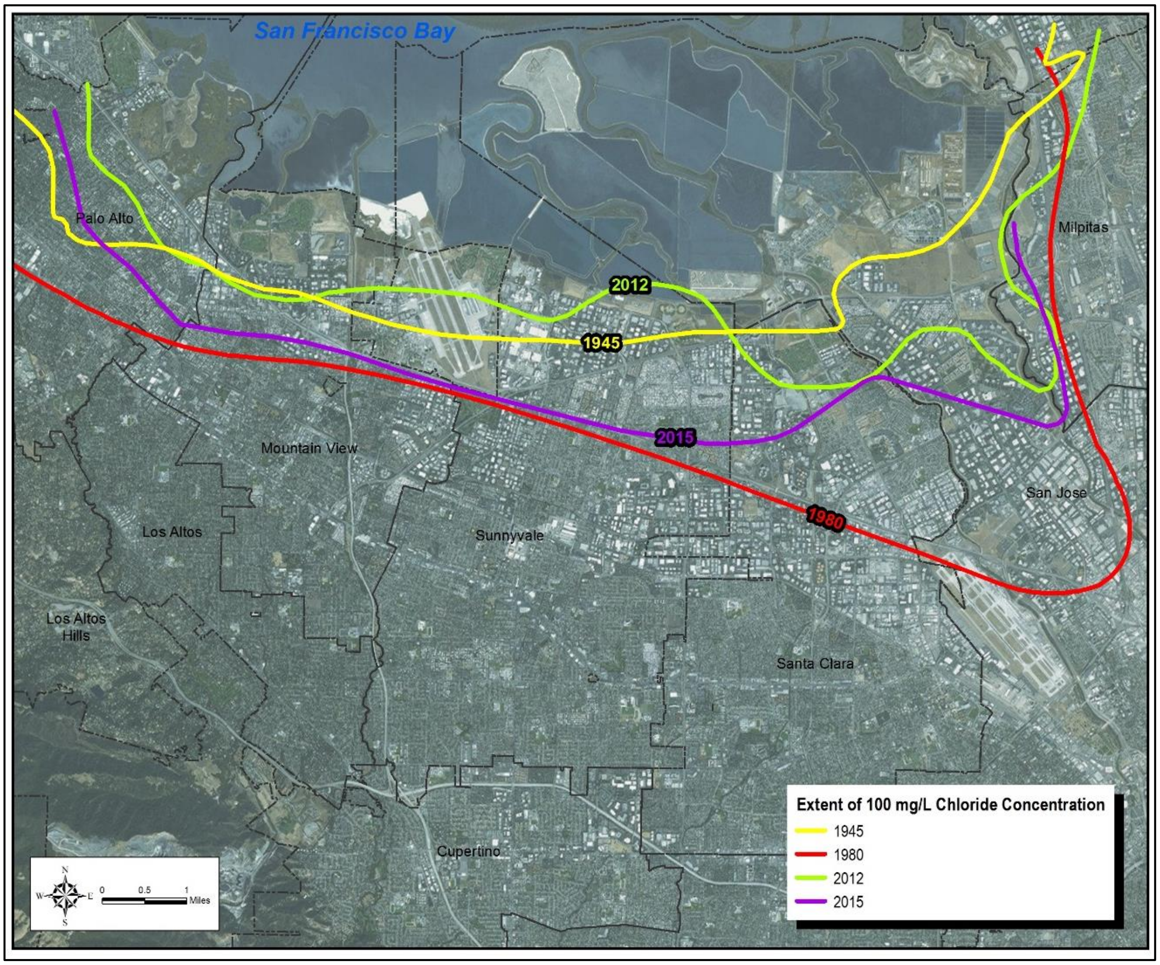


Figure 7. Extent of Shallow Zone Salt Water Intrusion

4.4 Improved Groundwater Quality

Recharge water can be of higher quality than the ambient groundwater so an improved water budget from District activities can also improve groundwater quality. For example, nitrate concentrations are high in ambient groundwater in portions of the Llagas Subbasin, but imported water used for managed aquifer recharge has a dilution benefit by adding water with low nitrate concentrations to the water budget (MACTEC, 2009). SCVWD's study of nitrate in domestic wells in the Llagas Subbasin found that 14% of wells within 2,000 feet of District recharge facilities exceeded the nitrate maximum contaminant limit (MCL), while 40% of wells tested in all other areas exceeded the MCL (SCVWD, 2012). These groundwater quality benefits from specific District recharge activities generally cover a smaller area than benefits represented by groundwater level changes so this smaller area of water quality benefits do not represent the entire area benefiting from the specific activities.

Groundwater protection activities also conserve and improve groundwater quality. Maintaining groundwater quality improves the reliability of the groundwater supply to meet drinking water standards, irrigation quality requirements, and quality needs of other uses. These activities are distributed widely through the District's service area and benefit the entire subbasin. In general, since all groundwater users benefit from these groundwater protection measures, the Study does not focus on groundwater quality for defining groundwater benefit zones.

4.5 Water Reuse Benefits

The District partners and collaborates with recycled water producers, wholesalers, retailers, users, and other interested parties to develop and expand recycled and purified water within the County. Increasing recycled and purified water benefits County groundwater supplies by alleviating stress on existing potable water supply infrastructure during droughts, and provides an alternative local, drought-proof, and reliable water supply to the County.

Some of these partnerships include four agencies that produce recycled water in the County (Palo Alto/Mountain View Recycled Water System, South Bay Water Recycling Program [SBWRP], South County Regional Wastewater Authority [SCRWA], and City of Sunnyvale Recycled Water System) along with other stakeholders. The District is developing a Countywide Water Reuse Master Plan (CWRMP) to identify future potential stakeholder partnerships and determine the institutional agreements needed to advance recycled and purified water. The vision of the CWRMP is a collaborative strategy to integrate and expand recycled and purified water as a local, reliable, environmentally adaptive, drought-proof water supply and guide strategic investment of public funds over the next 20 years.

5 HYDROGEOLOGICALLY CONNECTED AREAS

District activities provide groundwater benefits beyond the immediate location of an activity. Groundwater flow patterns control how benefits extend beyond the activity locations. The Study maps hydrogeologic features that affect groundwater flow to define areas hydrogeologically connected to District activities. Mapped features include contacts between water-bearing sediments and bedrock, and the location of groundwater divides separating subbasins. Other geologic features that may define the limits of hydrogeologic connection include faults, where alluvium narrows and/or steepens, and contacts between geologic formations with different levels of consolidation. The boundaries for the hydrogeologically connected areas are based on some of these features.

5.1 Alluvium Contact with Bedrock

The hydrogeologically connected areas are primarily defined by the geologic contact between unconsolidated to semi-consolidated alluvium and consolidated bedrock of the adjacent mountain ranges. Alluvium are primarily sediments that eroded from adjacent mountain ranges by flowing water and deposited in the Valley during the current geologic age (Quaternary age) that began approximately 2.6 million years ago. The bedrock of the adjacent Santa Cruz Mountains and Diablo Range are primarily composed of sedimentary, metamorphic, and volcanic rocks formed in Jurassic, Cetaceous, and Tertiary periods older than 2.6 million years ago (SCVWD, 2016). In addition to bounding the hydrogeologically connected areas of alluvium laterally, bedrock underlies the alluvium (Figure 8).

Alluvium includes fine sediments of silt and clay and coarser sediments of sand and gravel. Groundwater flows through spaces (pores) in these sediments. Groundwater generally flows through the pores of the alluvium until encountering bedrock or other hydrogeologic boundaries so continuous areas of alluvium generally hydrogeologically connected. This groundwater flow through porous media provides greater potential for connecting areas with groundwater users to benefits from District activities than in bedrock. Bedrock is consolidated so groundwater flow typically occurs in bedrock fractures that have not been mapped and may be limited in extent. District activities can benefit the groundwater supply of these fractures but the extent of the benefit would be limited by the unknown extent of fractures. Therefore, the bedrock/alluvium contact within Santa Clara County is the basis for the hydrogeologically connected areas used to define the extent of potential benefit. Quaternary deposits and artificial fill mapped at the surface that are not specifically labeled alluvium are included in the Study's definition of alluvium because they are relatively young (< 2.6 million years) deposits and are relatively permeable compared to the older bedrock that bounds the basin.

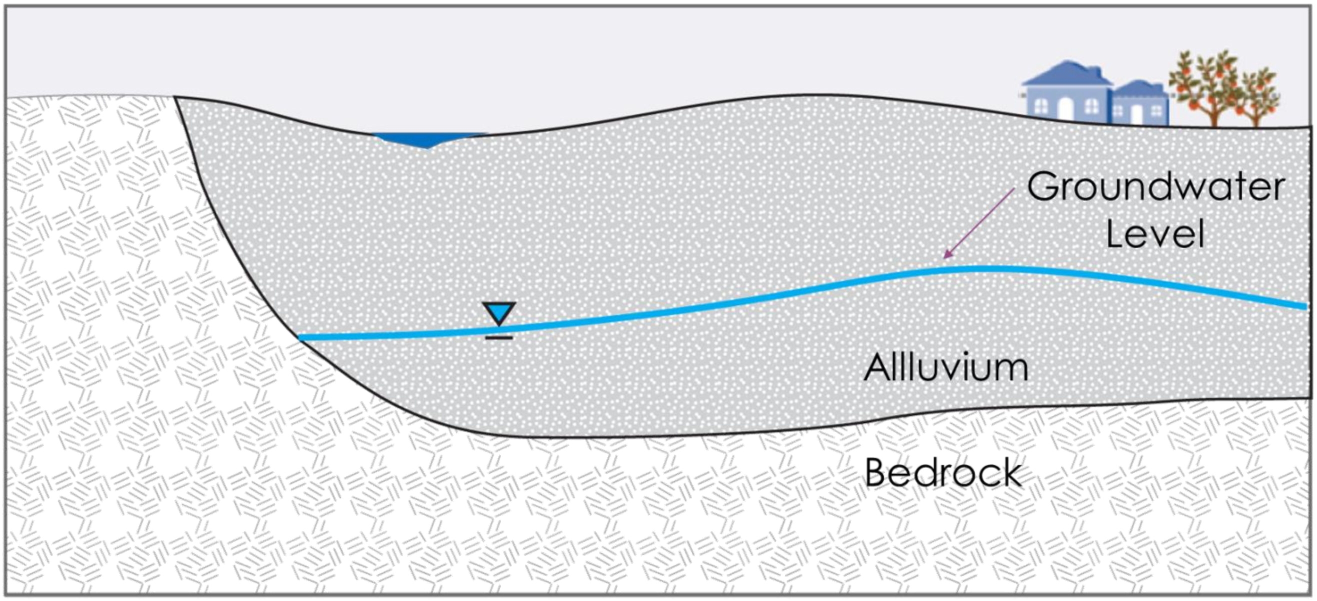


Figure 8. Schematic Cross-Section of Alluvium and Bedrock

5.1.1 Geologic Maps

The bedrock/alluvium contact is based on existing maps by the U.S. Geological Survey (USGS) and California Geological Survey (CGS). The Study uses GIS formats of these maps that were downloaded from USGS websites.

Two 30 x 60-minute quadrangles are used for this study: Palo Alto (Brabb et al., 2000) and San Jose (Wentworth et al., 1999). The Palo Alto quadrangle covers the northwestern portion of the County from Stanford to Saratoga, with its eastern boundary just west of the North-South Lawrence Expressway. The San Jose quadrangle covers the County from the Palo Alto quadrangle to West 10th St/Highway 152 in Gilroy in the Llagas subbasin. Maps of Quaternary deposits for the San Francisco Bay Region (Witter et al., 2006) are used to cover the rest of the County to the South. Even though it covers the whole County, this regional map has more generalized groupings of geologic formations so the more detailed Palo Alto and San Jose quadrangles are used where available. Figure 9 shows the unified geology from all three maps used in this study.

The listed scale of the Palo Alto quadrangle is 1:62,500 and the listed scale of the San Jose quadrangle and regional map is 1:24,000. The USGS accuracy standard requires that 90% of known points must be within 0.02 inches on the map. For 1:24,000 scale, this translates to an accuracy of 40 feet and for 1:62,500, this translates to an accuracy of approximately 105 feet. However, geologic maps involve interpretation between known points and interpretation likely results in some additional inaccuracies.

5.1.2 Alluvium Formations

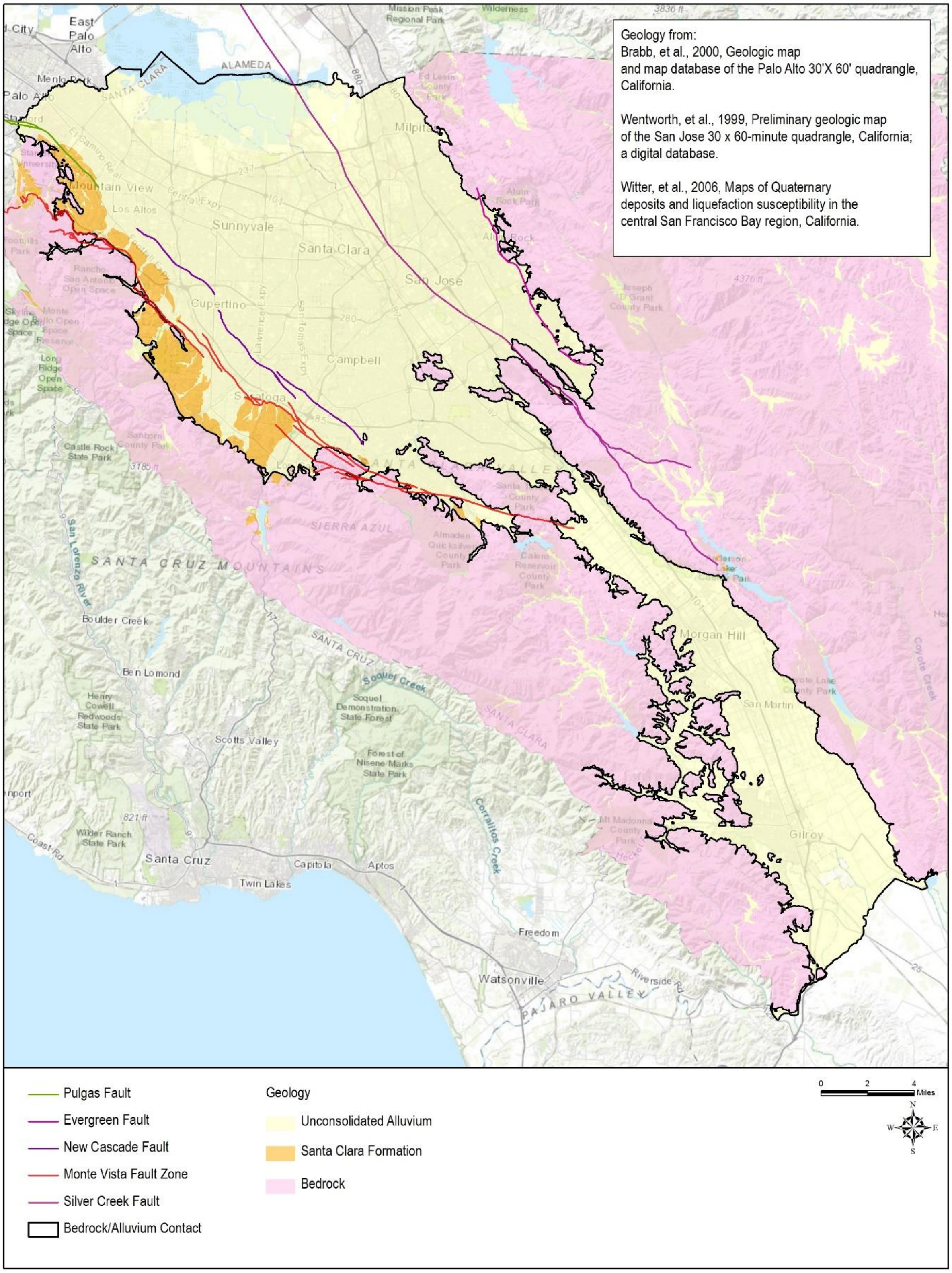
Alluvium in Santa Clara County primarily consists of unconsolidated sediments, lenses of clay, silt, sand, and gravel deposited in the Holocene (younger than 12,000 years old) and Pleistocene epochs (12,000 to 2.6 million years ago), that this report refers to as Unconsolidated Alluvium. Unconsolidated Alluvium is mapped from the northern to the southern boundary of Santa Clara County. Figure 9 distinguishes Unconsolidated Alluvium from the slightly older Santa Clara Formation located on the west side of the Santa Clara Plain. The Santa Clara Formation consists of slightly consolidated or semi-consolidated alluvium deposited during the early Pleistocene and Pliocene epochs (2.6 million to 5.8 million years ago). Groundwater flow through Unconsolidated Alluvium and Santa Clara Formation is through porous media but permeability of Santa Clara Formation is less certain than Unconsolidated Alluvium. Section 5.6 provides additional discussion of hydrogeologic connection in the Santa Clara Formation and between Unconsolidated Alluvium and Santa Clara Formation

5.2 Groundwater Divide

Groundwater divides occur between areas where groundwater flows in opposite directions. The primary groundwater divide in the County is the divide at the southern end of Coyote Valley that is used by the California Department of Water Resources (DWR) to define the boundary between the Santa Clara and Llagas Subbasins (DWR, 2003). North of this divide, groundwater flows to the north. South of this divide, groundwater flows to the south.

The groundwater divide changes slightly over time based on recharge and pumping conditions so groundwater contours maps developed by the District for 1975-2015 were reviewed. Figure 10 shows spring and fall groundwater contours from 2000-2002 and Figure 11 shows spring and fall groundwater contours from 2013-2015 for years when the District developed groundwater contours for the area of the groundwater divide in GIS format. The contours affirm that the DWR basin boundary is a representative approximation of the groundwater divide over time and an appropriate boundary for hydrogeologically connected areas used to define the extent of potential benefit.

The contour maps also show that other groundwater divides may appear seasonally but are not consistent throughout the year. For example, in the spring, the north part of the County has a divide between flow north toward the Bay and south towards pumping depressions but this divide is not maintained throughout the year and does not establish a boundary for hydrogeologically connected areas. A consistent groundwater divide other than the subbasin boundary is also not evident in historical contour maps created by the District for 1975-1999.



Geology from:
Brabb, et al., 2000, Geologic map and map database of the Palo Alto 30'X 60' quadrangle, California.

Wentworth, et al., 1999, Preliminary geologic map of the San Jose 30 x 60-minute quadrangle, California; a digital database.

Witter, et al., 2006, Maps of Quaternary deposits and liquefaction susceptibility in the central San Francisco Bay region, California.

Figure 9. Geology of Santa Clara County

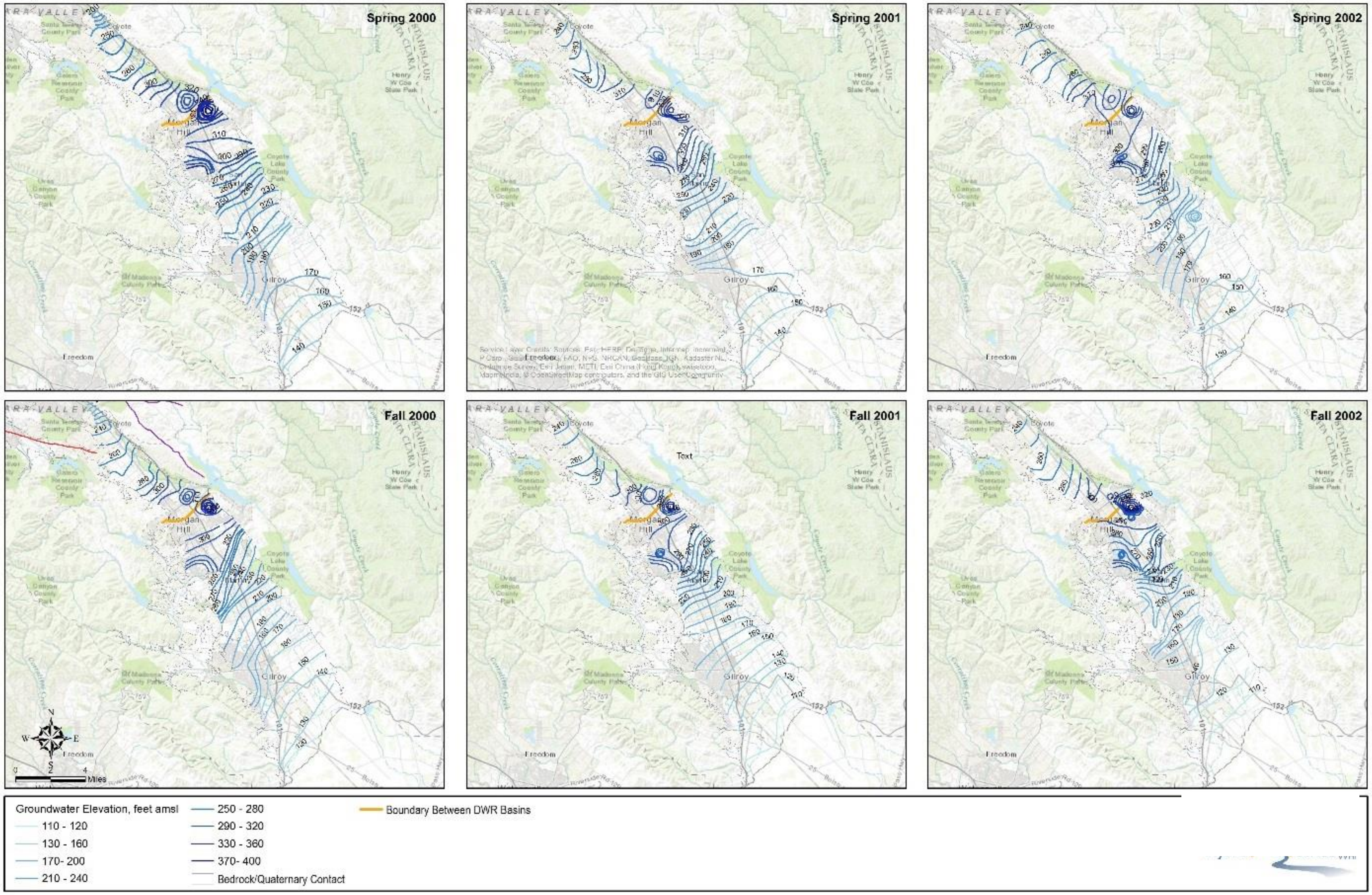


Figure 10. Spring and Fall Groundwater Elevation Contours for Coyote Valley and Llagas Subbasin 2000-2002

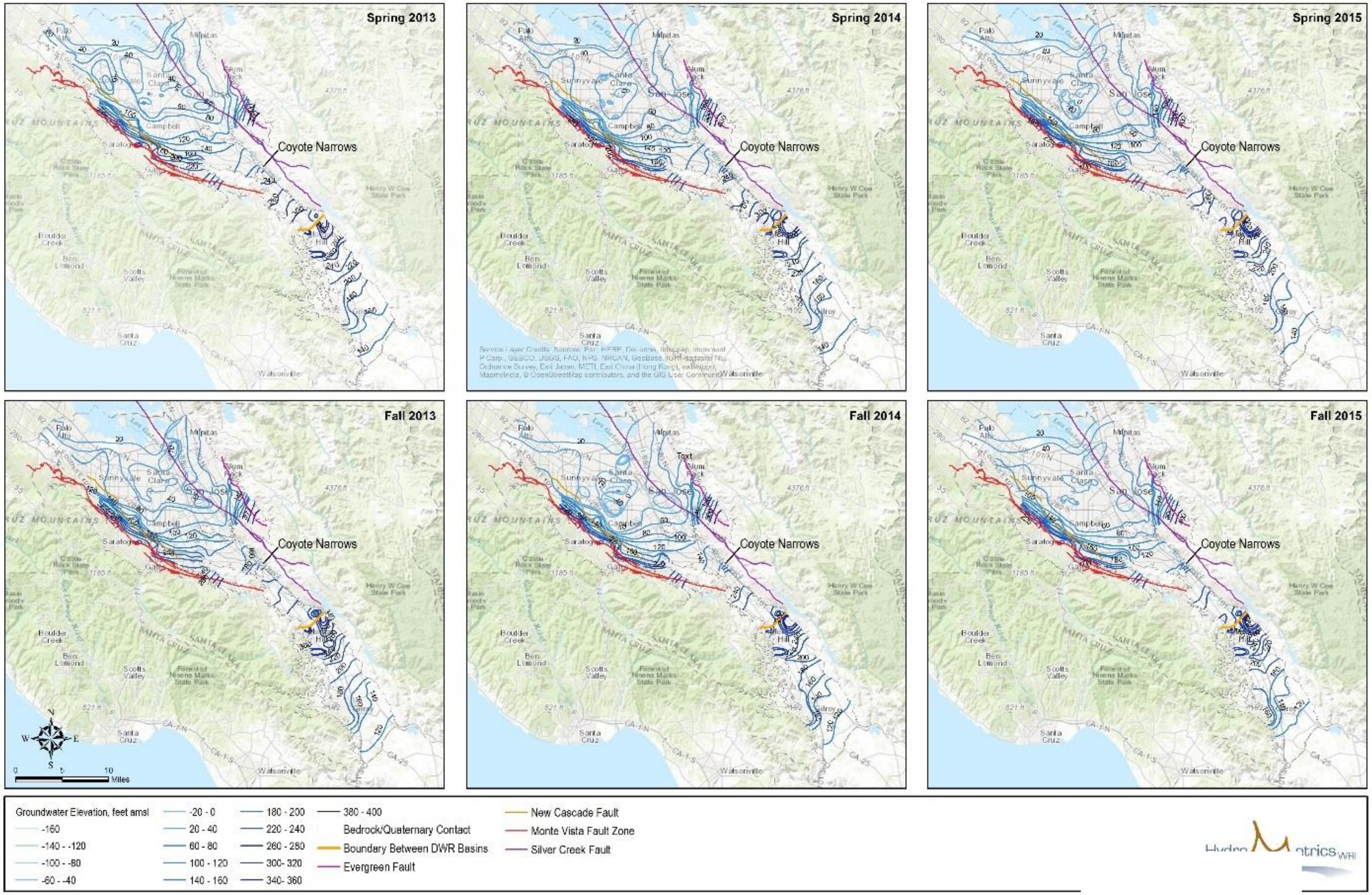


Figure 11. Spring and Fall Groundwater Level Elevation Contours for Santa Clara Subbasin 2013-2015

5.3 Faults

Faults can be barriers to groundwater flow. However, faults are not necessarily definitive and significant barriers to flow that limit the extent of benefits from District activities. Previous studies identified the faults that are most likely to be significant barriers to flow. This Study evaluates whether these faults are significant barriers to flow by comparing fault locations with the groundwater level contour maps. The Study assigns faults previously identified as possible barriers to groundwater flow as hydrologic boundaries if the extent of District activity benefits, as estimated by the groundwater level evaluation (Section 8) and modeling evaluation (9), indicate benefits may be limited by the fault.

Fault locations that may be flow barriers were derived from a number of studies. The most recent USGS study of the hydrogeology of the Santa Clara Plain (Wentworth et al., 2015) identifies several faults as at least partial barriers to groundwater flow. Interferometric synthetic-aperture radar (InSAR) imagery indicates a subsidence boundary at the Silver Creek Fault in the eastern part of the subbasin (Galloway et al., 2000). Hanson et al. (2004) includes three segments of this fault and the nearby North Evergreen Fault as horizontal flow barriers in a groundwater model. Based on the model calibration, the greatest barriers to flow in this area are two southern segments of the Silver Creek Fault in layers 3-6 in the model where layers 3-5 represent the confined unit in the subbasin from which most production occurs (CH2M Hill, 1992). However, there is a gap included in the fault near Coyote and Silver Creeks to simulate stream recharge across the fault.

Hanson et al. (2004) also simulates the Monte Vista and New Cascade Faults as horizontal flow barriers in model layers 3-6 to reduce groundwater levels in the central part of the subbasin. The model also includes gaps at District managed recharge facilities Ross Creek and Stevens Creek of the West Side system and Los Gatos Creek to simulate stream recharge across the fault.

Groundwater level contours for 2013-2015 (Figure 11) developed by the District do not indicate a barrier to groundwater flow across these faults based on GIS files produced by the USGS and CGS (2010). However, the contours do not extend west of the Monte Vista Fault into the mapped outcrop of the Santa Clara Formation (Section 5.6).

Given there is inconsistent information about whether these faults are barriers to groundwater flow, and there is likely some flow across the faults, faults are identified as boundaries only if benefits from a District activity are only demonstrated on one side of the fault.

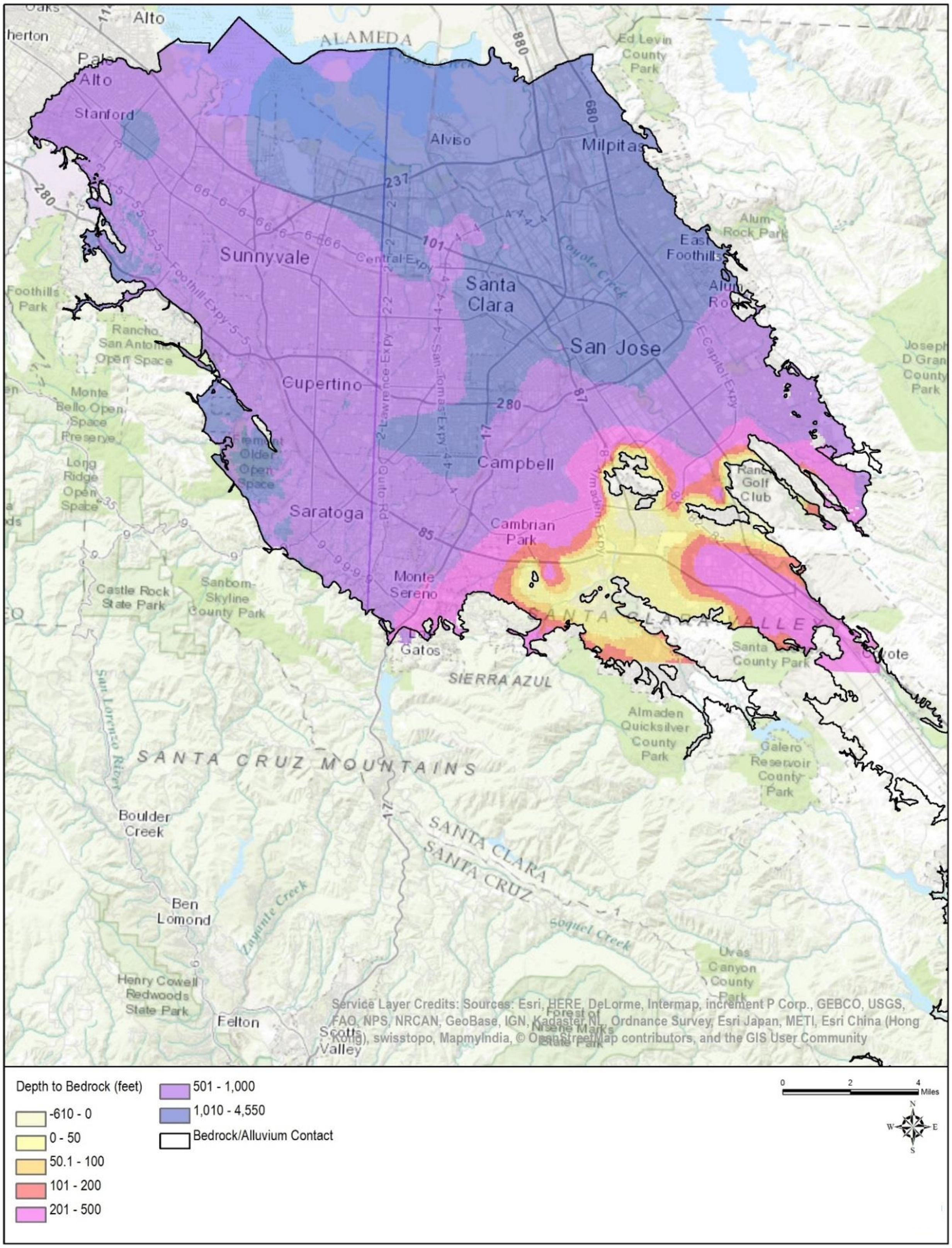
Wentworth et al. (2010) evaluates evidence for other historically inferred faults in the basin and concludes most of those previously identified faults do not extend into the alluvium of the subbasin. No faults have been identified as barriers to groundwater flow in the alluvium of Coyote Valley and the Llagas Subbasin.

5.4 Stratigraphic Thickness

The Study uses interpreted stratigraphy to map the thickness of the alluvium including Unconsolidated Alluvium and Santa Clara Formation. Large changes in thickness or stratigraphy could be geologic features that affect how groundwater flows between areas. If the thickness decreases over a small distance, groundwater flow can be constricted and limit the hydrogeologic connection across the change in thickness. The Study calculates and maps depth to bedrock in the alluvium of the Santa Clara Plain (Figure 12) based on GIS files for bedrock elevation developed by Wentworth et al. (2010) and ground surface elevation based on the USGS Digital Elevation Model. The 2015 USGS report (Wentworth et al., 2015) identifies continuous sedimentary stratigraphy from San Jose to the Palo Alto area

While the map of stratigraphic thickness shows an area of thinner Unconsolidated Alluvium in the area north of Coyote Narrows, groundwater level contours do not show that it affects groundwater flow (Figure 11). The area of reduced thickness is not considered a limit on the area of hydrogeologic connection.

Although similar data sets are not available for the Coyote Valley and Llagas management areas, depths implemented in the model do not show substantial changes in thickness over short distances and groundwater contour maps do not indicate a constriction of flow due to thickness changes.



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 12. Depth to Bedrock Based on USGS Stratigraphy (Wentworth et al., 2015)

5.5 Constrictions of Unconsolidated Alluvium

A geologic feature that may affect hydrogeologic connectivity occurs when the Unconsolidated Alluvium constricts between bedrock outcrops. Even though groundwater flow may occur through such a constriction, the constriction may have enough effect that the hydrogeologic connection transmitting benefits from District activities is limited.

5.5.1 Coyote Narrows

The existing boundary between Zones W-2 and W-5 is located at the Coyote Narrows between the Santa Clara Plain and Coyote Valley. Groundwater level contour maps (Figure 11) show a steep gradient in this area. This indicates that the constriction is affecting groundwater flow substantially and may limit hydrogeologic connection across the boundary. The existing zone boundary may approximate a boundary for hydrogeologically connected areas if benefits from a District activity are only demonstrated on one side of the Narrows.

5.5.2 Bedrock Outcrops in Llagas Subbasin

There are several bedrock outcrops in the Llagas Subbasin that may affect the hydrogeologic connection of Unconsolidated Alluvium within Llagas Basin (Figure 13). Similar to Coyote Narrows, these bedrock outcrops may constrict groundwater flow through Unconsolidated Alluvium thereby limiting hydrogeologic connection. These narrow Unconsolidated Alluvium connections which may be appropriate to use as a boundary if benefits from a District activity are only demonstrated on one side of the outcrop constrictions. Groundwater level maps are not available to show gradients across these constrictions.

5.5.3 Narrow Alluvial Channels

Another constriction of Unconsolidated Alluvium is where narrow and steep streambed alluvium channels flow through bedrock areas into downstream areas of Unconsolidated Alluvium. The constriction may limit the hydrogeologic connection between activities in the downstream areas with the upstream channel. Therefore, the constrictions may be appropriate to use as a boundary. Groundwater level maps are not available to show gradients across these constrictions, but stream elevations in connection with groundwater in the shallow alluvial channels are typically much higher than groundwater levels in the downstream areas. Ground surface elevations and data for alluvial thicknesses can be used to evaluate where this limitation on hydrogeologic connection occurs.

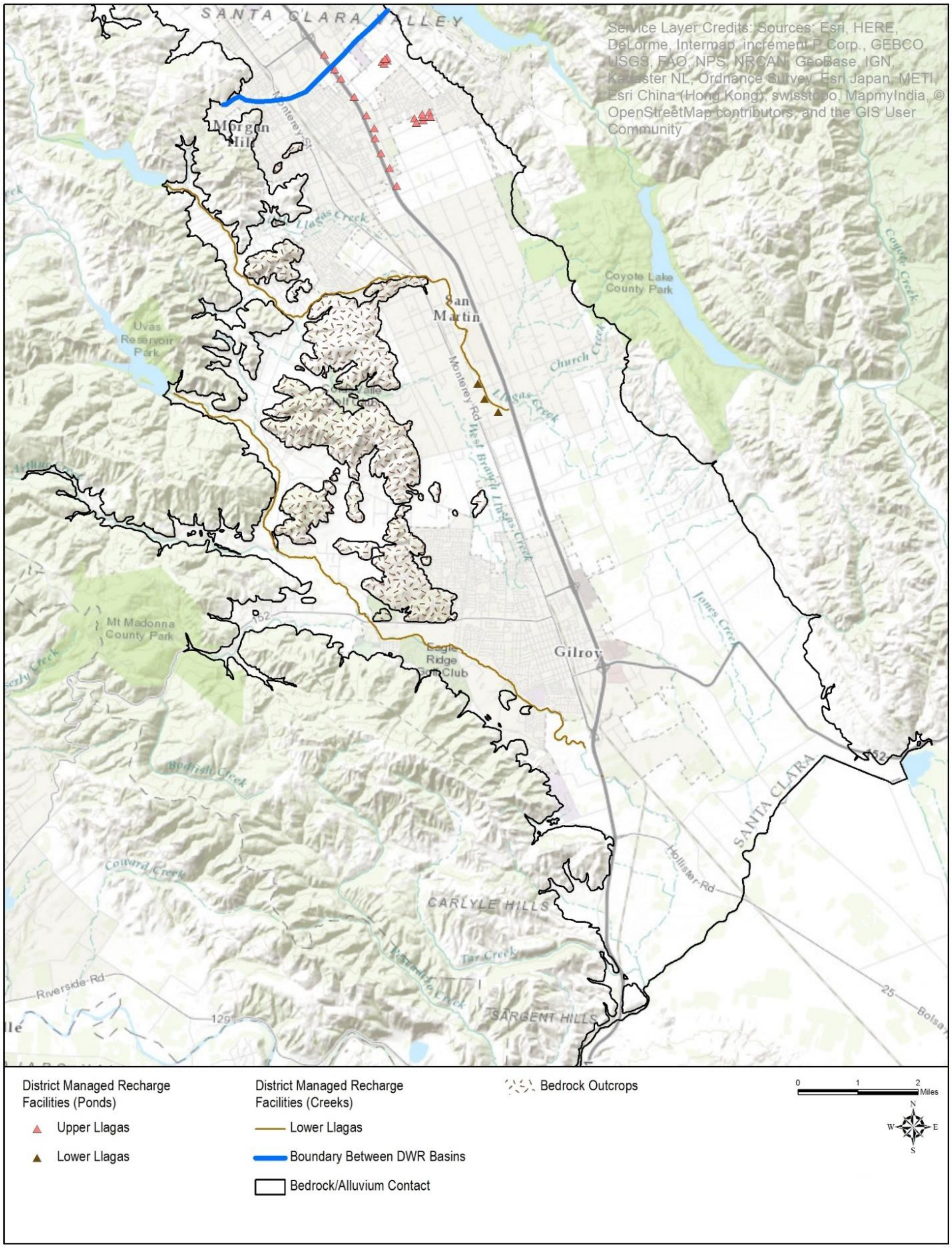

SANTA CLARA VALLEY
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Morgan Hill
Llagas Creek
San Martin
Coyote Lake County Park
Coyote Creek
Uvas Reservoir Park
Church Creek
Monterey Rd
West Branch Llagas Creek
Mt Madonna County Park
152
Eagle Ridge Golf Club
Gilroy
Jones Creek
Bodfish Creek
Coward Creek
CARLYLE HILLS
Tar Creek
Hollister Rd
SANTA CLARA
Riverside Rd
129
SARGENT HILLS
25
Bolsa
District Managed Recharge Facilities (Ponds)
▲ Upper Llagas
▲ Lower Llagas
District Managed Recharge Facilities (Creeks)
Lower Llagas
Boundary Between DWR Basins
☐ Bedrock/Alluvium Contact
Bedrock Outcrops
0
1
2
Miles
N
W
E
S

Figure 13. Locations of Bedrock Outcrop Constrictions in Llagas Subbasin

5.6 Santa Clara Formation

Descriptions of the water bearing alluvium in the Santa Clara Plain distinguish between the Santa Clara Formation of Plio-Pleistocene age and the other Pleistocene-Holocene deposits referred to in this report as Unconsolidated Alluvium. DWR's description of the Santa Clara Subbasin describes the Unconsolidated Alluvium as the more important water bearing unit for the subbasin (DWR, 2003). Figure 14 shows the largest surface outcrop of the Santa Clara Formation on the west-side of the subbasin where it has been described as "poorly sorted, irregularly bedded material ranging in grain size from silt to boulders" (DWR, 1975). Other studies have described the Santa Clara Formation as partly non-water bearing in this outcropping area (Wentworth et al., 2015), however there are wells that extract groundwater throughout this area as shown on Figure 13. Pumping data are available for wells in the outcropping area of the Santa Clara Formation that are also within current Zone W-2 and production for 2015 totaled 557 acre-feet. In addition, the description of the Santa Clara Formation indicates that groundwater flow is flow through pore spaces in the Formation materials, not through fractures as in bedrock. It is reasonable to consider connected areas of the Santa Clara Formation as hydrogeologically connected though there is a lack of data that can be evaluated for hydrogeologic connection beyond mapping of geology and pumping wells in the area.

There is a lack of information documenting a hydrogeological connection between the Santa Clara Formation and the Unconsolidated Alluvium. In addition, the previous presumption that the Santa Clara Formation underlies Unconsolidated Alluvium towards the center of the basin (DWR, 1975) has been questioned by Wentworth et al. (2015) who concluded that there is little evidence for its existence much closer to the center of the basin than the surface outcrops shown in Figure 13. Therefore, it is not reasonable to conclude that there is a hydrogeologic connection between the Santa Clara Formation and Unconsolidated Alluvium. Benefits from District activities to extend from one geologic formation to the other must be demonstrated by data and modeling, if available.

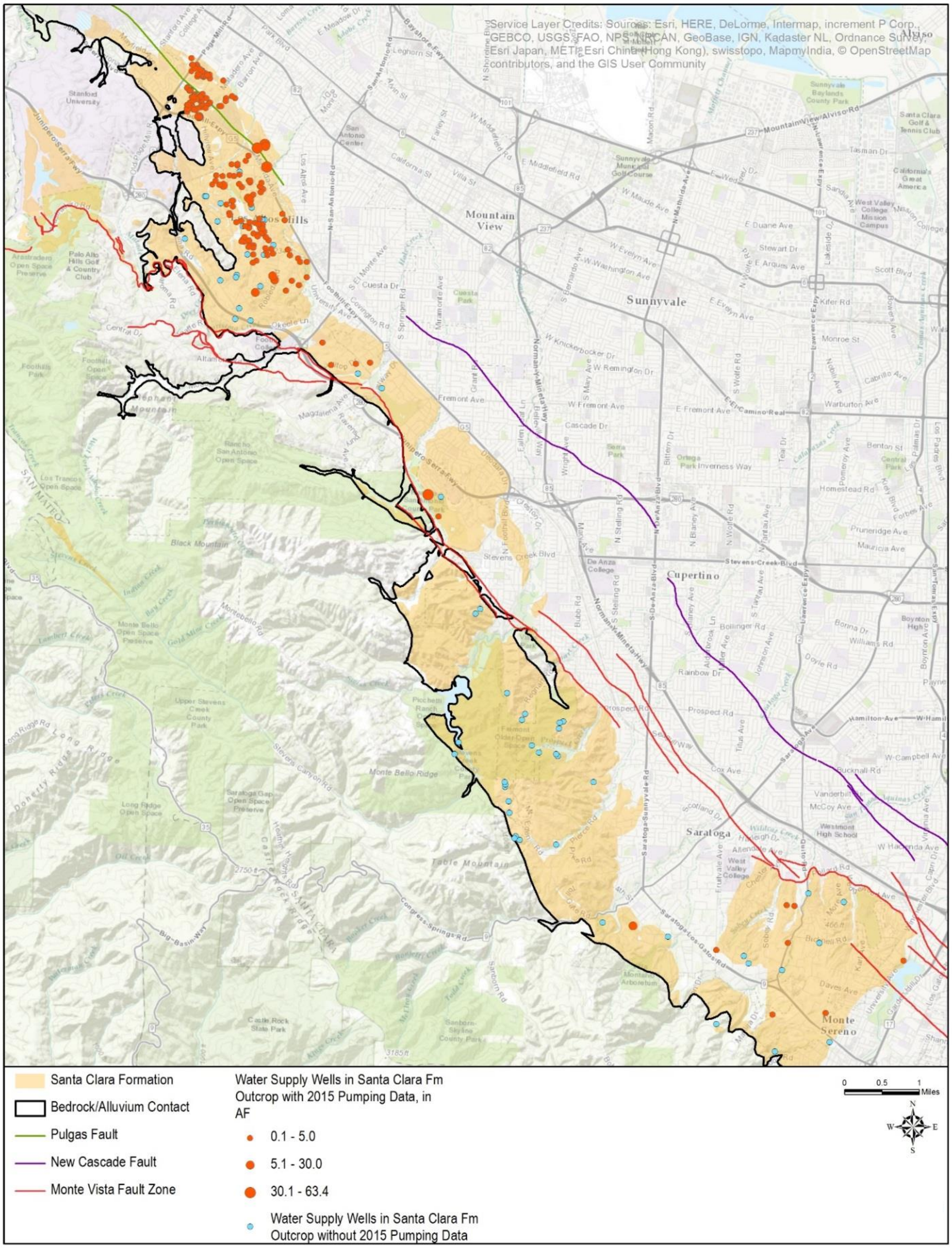

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Mountain View
Sunnyvale
Cupertino
Saratoga
Monte Sereno
Los Altos Hills
Santa Clara Formation
Bedrock/Alluvium Contact
Pulgas Fault
New Cascade Fault
Monte Vista Fault Zone
Water Supply Wells in Santa Clara Fm Outcrop with 2015 Pumping Data, in AF
0.1 - 5.0
5.1 - 30.0
30.1 - 63.4
Water Supply Wells in Santa Clara Fm Outcrop without 2015 Pumping Data
0 0.5 1 Miles
N
W
E
S

Figure 14. Santa Clara Formation Outcrop along Westside of Santa Clara Sub-basin

6 BENEFITS TO WATER BUDGET IN HYDROGEOLOGICALLY CONNECTED AREAS FROM DISTRICT ACTIVITIES

Water budgets for potentially hydrogeologically connected areas demonstrate the general benefits from the District's managed and in-lieu groundwater replenishment activities. The potentially hydrogeologically connected areas are based on the Bedrock/Alluvium contact and the groundwater divide that is DWR's boundary between subbasins. Plots of water budgets are provided for the Santa Clara Subbasin including Santa Clara Plain and the Coyote Valley and the Llagas Subbasin. The plots show need for District groundwater replenishment activities, benefit from managed aquifer recharge activities, and benefit from in-lieu recharge activities.

6.1 Need for District Groundwater Replenishment Activities

Natural recharge is not sufficient to support groundwater pumping in the subbasins. Figure 15 compares annual natural recharge to annual groundwater pumping in the Santa Clara Subbasin. Since 2003, groundwater pumping has been approximately 3 times the natural recharge for the Santa Clara Subbasin. Figure 16 compares annual natural recharge to annual groundwater pumping in the Llagas Subbasin. Since 2003, groundwater pumping has been approximately two times the natural recharge for the Llagas Subbasin. Groundwater replenishment activities are needed to balance groundwater pumping with total recharge for both subbasins. If groundwater pumping were to exceed recharge, groundwater levels would decline, resulting in less reliable groundwater supply and increased risk of land subsidence and saltwater intrusion. The plots show that groundwater replenishment activities are needed in all years.

6.2 Benefits to Water Budget from Managed Aquifer Recharge Activities

District managed aquifer recharge activities provide benefits to the subbasin water budget by making up most of the difference between groundwater pumping and natural recharge. Figure 17 and Figure 18 stack annual volumes of District managed aquifer recharge on top of natural recharge in order to compare total recharge with groundwater pumping in each of the subbasins. By helping to balance total recharge with groundwater pumping and improving groundwater levels, these managed aquifer recharge activities provide benefits of a more reliable groundwater supply and reduced risk of land subsidence and saltwater intrusion. Since pumping exceeds natural recharge in all years, District managed aquifer recharge always provides the benefit of balancing recharge and pumping.

Figure 17 includes managed recharge at the following systems that can recharge both imported water and local runoff to benefit the Santa Clara Subbasin water budget:

- West Side
- Los Gatos
- Guadalupe
- Coyote
- Penitencia

Figure 18 includes managed recharge at the following systems to benefit the Llagas Subbasin water budget:

- Upper Llagas system that can recharge both imported water and local runoff
- Lower Llagas system that recharges only local runoff captured and stored in the District’s Uvas and Chesbro Reservoirs

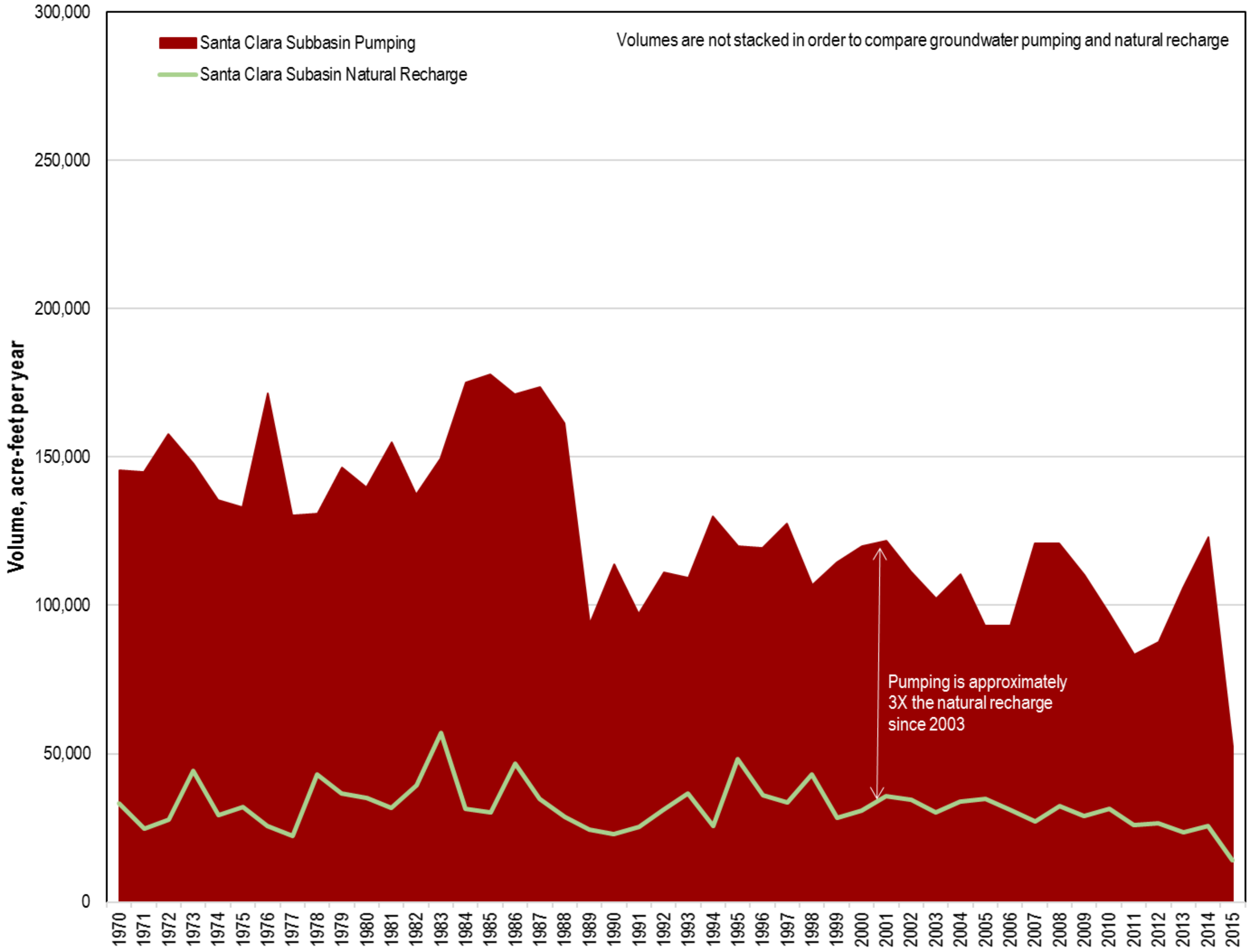


Figure 15. Santa Clara Subbasin Natural Recharge vs. Groundwater Pumping

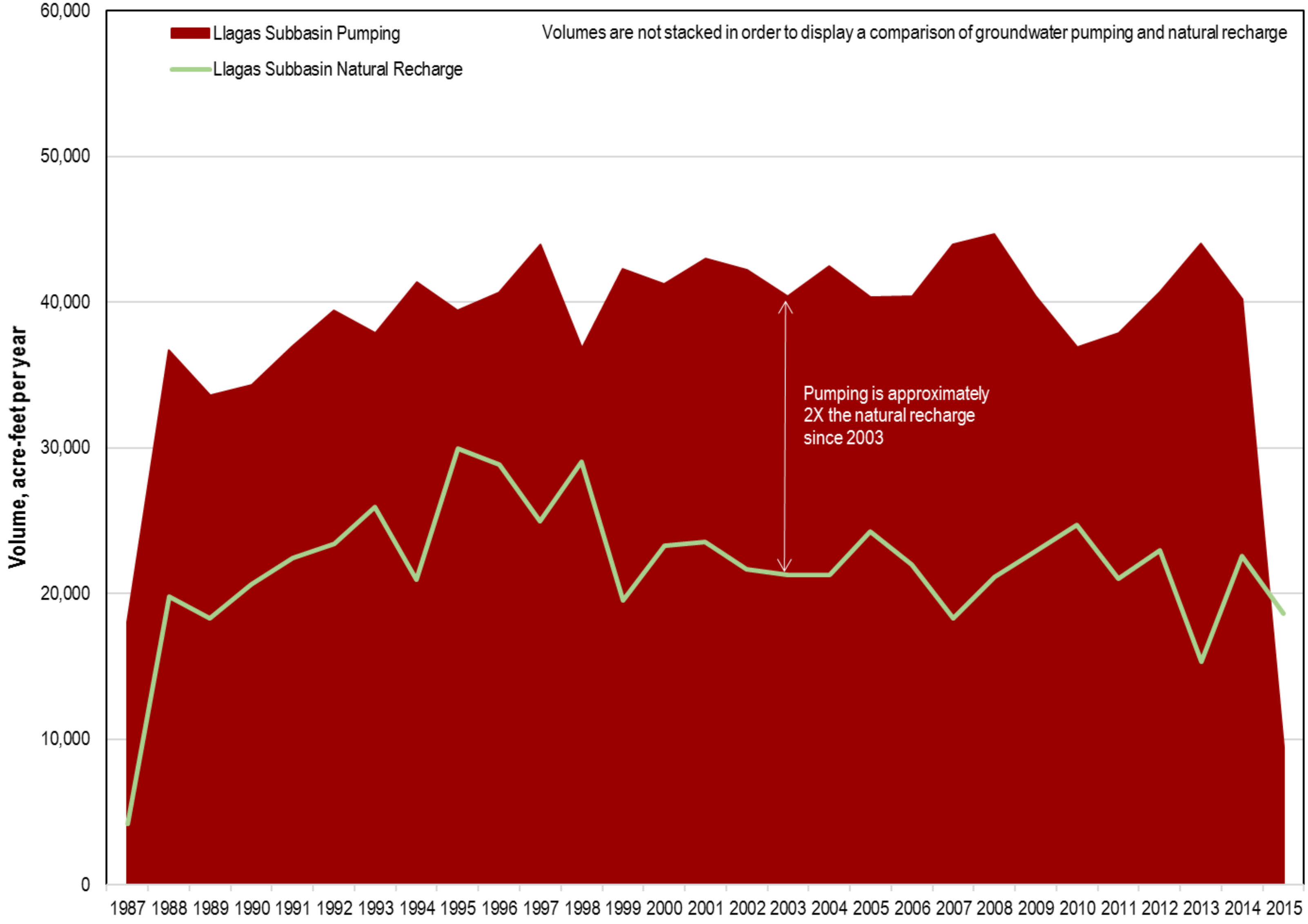


Figure 16. Llagas Subbasin Natural Recharge vs. Groundwater Pumping

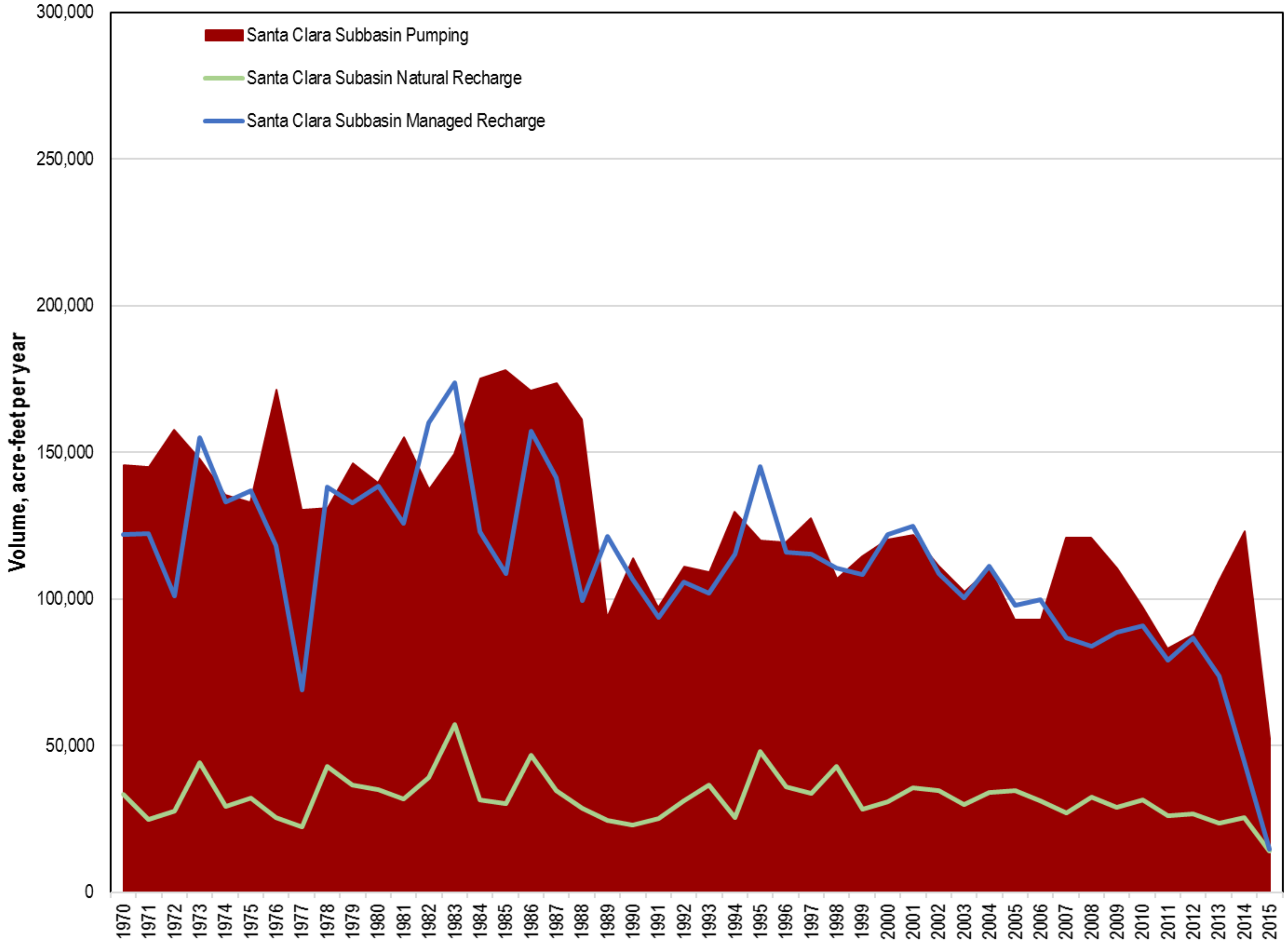


Figure 17. Santa Clara Subbasin Total Recharge vs. Groundwater Pumping

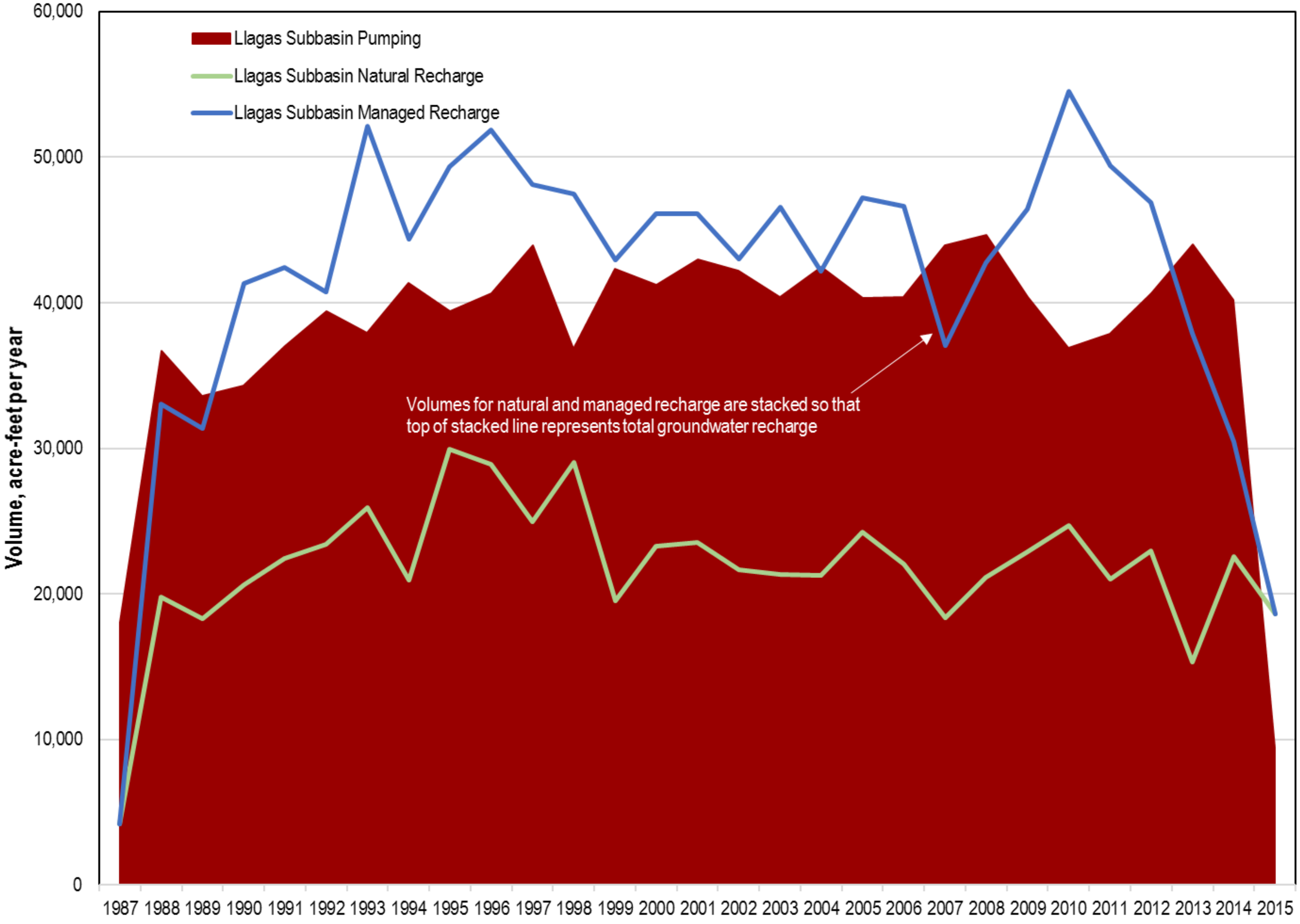


Figure 18. Llagas Subbasin Total Recharge vs. Groundwater Pumping

6.3 Benefits to Water Budget from In-Lieu Recharge Activities

The District's in-lieu recharge activities benefit the water budgets for the subbasins by reducing groundwater pumping. For Santa Clara Subbasin and Llagas Subbasin, respectively, Figure 19 and Figure 20 show these benefits by stacking in-lieu recharge on top of groundwater pumping. The stacked in-lieu recharge amounts show what pumping quantities would be without District activities and therefore how in-lieu recharge improves water budgets.

District in-lieu recharge activities in the Santa Clara Subbasin (Figure 19) primarily consist of treated water deliveries (stacked green area), but also include untreated surface water deliveries (dark blue stacked areas) and recycled water deliveries (stacked purple areas). Without District in-lieu recharge activities in the Santa Clara Subbasin, groundwater pumping would exceed total recharge even with District managed recharge. If groundwater pumping were to exceed total recharge, groundwater levels would decline, resulting in less reliable groundwater supply and increased risk of land subsidence and saltwater intrusion. Therefore, in-lieu recharge provides benefits that improve groundwater levels, which in turn improves groundwater supply reliability and helps limit land subsidence and control saltwater intrusion. Since demand in the Santa Clara Subbasin exceeds total recharge in all years, District in-lieu recharge always provides benefits by meeting some of the demand and reducing pumping.

District in-lieu recharge activities in the Llagas Subbasin (Figure 20) consist of surface water deliveries (dark blue stacked areas) and recycled water deliveries (stacked purple areas). Without treated water deliveries in the Llagas Subbasin, District in-lieu recharge activities are less than what occurs in the Santa Clara Subbasin. Most of the time in the Llagas Subbasin, total recharge exceeds groundwater demand as represented by groundwater pumping plus in-lieu recharge. However,

shows how in-lieu recharge helps reduce groundwater pumping and allows total recharge to exceed pumping by greater amounts during wet years and reduces shortfall between pumping and total recharge in dry years.

Figure 19 includes the following District in-lieu recharge activities in the Santa Clara Subbasin:

- Delivery of treated water to retailers that reduces groundwater pumping and provides in-lieu recharge
- Recycled water deliveries by the Palo Alto, Sunnyvale, and South Bay Water Recycling systems supported by the District that reduces groundwater pumping and provides in-lieu recharge or allows for reduction of surface water deliveries without increasing groundwater pumping and therefore contributes to in-lieu recharge.

- Delivery of untreated surface water to specific parcels that reduces groundwater pumping and provides in-lieu recharge

Non-District activities, primarily the delivery of SFPUC Regional Water System imported water, also provide in-lieu recharge to the Santa Clara Subbasin. Total groundwater demand if these non-District activities were not taking place would be even higher than what is plotted in Figure 19 which only shows in-lieu recharge from District activities.

Figure 20 includes the following District in-lieu recharge activities in the Llagas Subbasin:

- Recycled water deliveries by the South County Regional Wastewater Authority supported by the District that reduces groundwater pumping and provides in-lieu recharge
- Delivery of untreated surface water to specific parcels that reduces groundwater pumping and provides in-lieu recharge

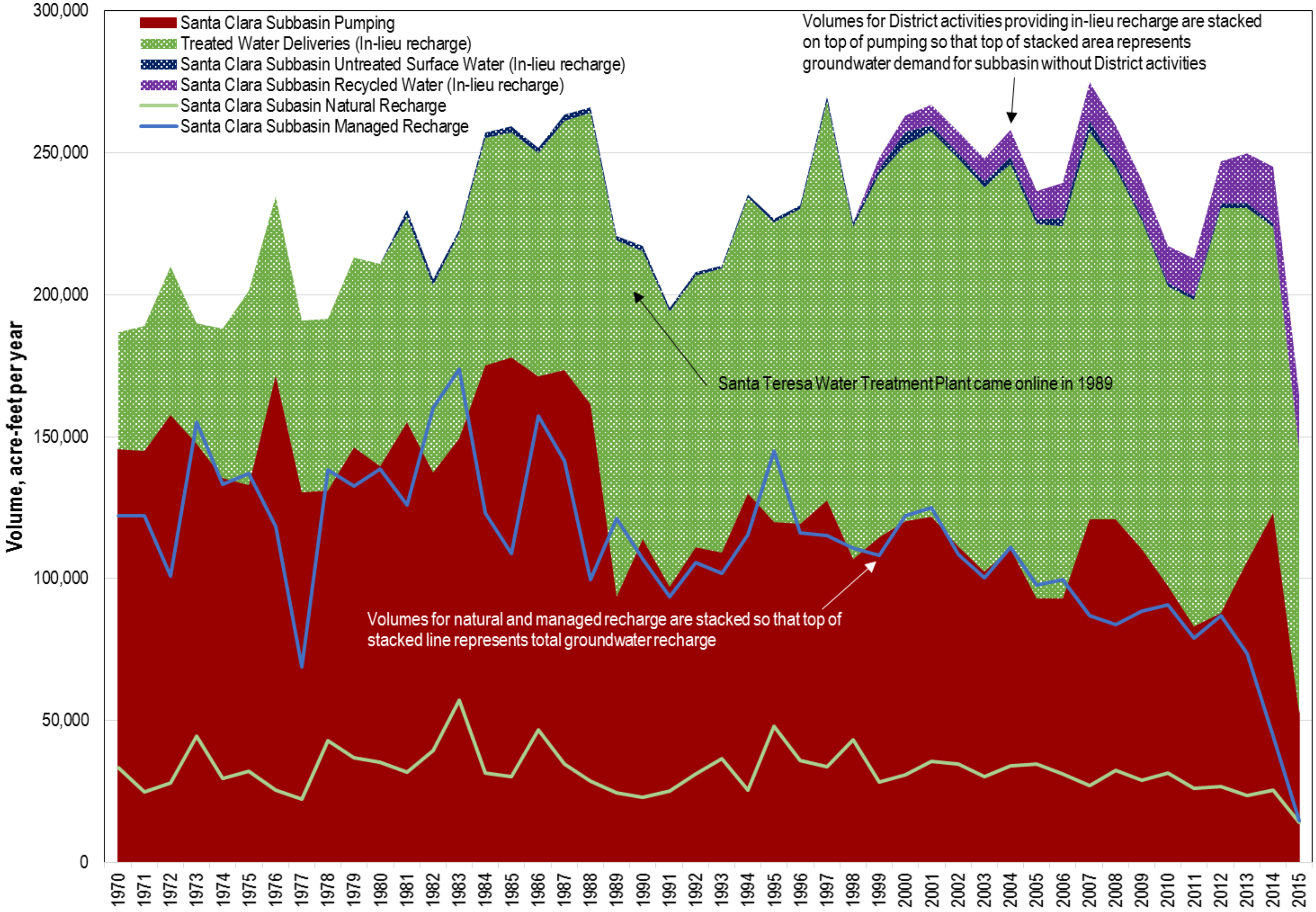


Figure 19. Santa Clara Subbasin Water Budget with District In-Lieu Recharge Activities

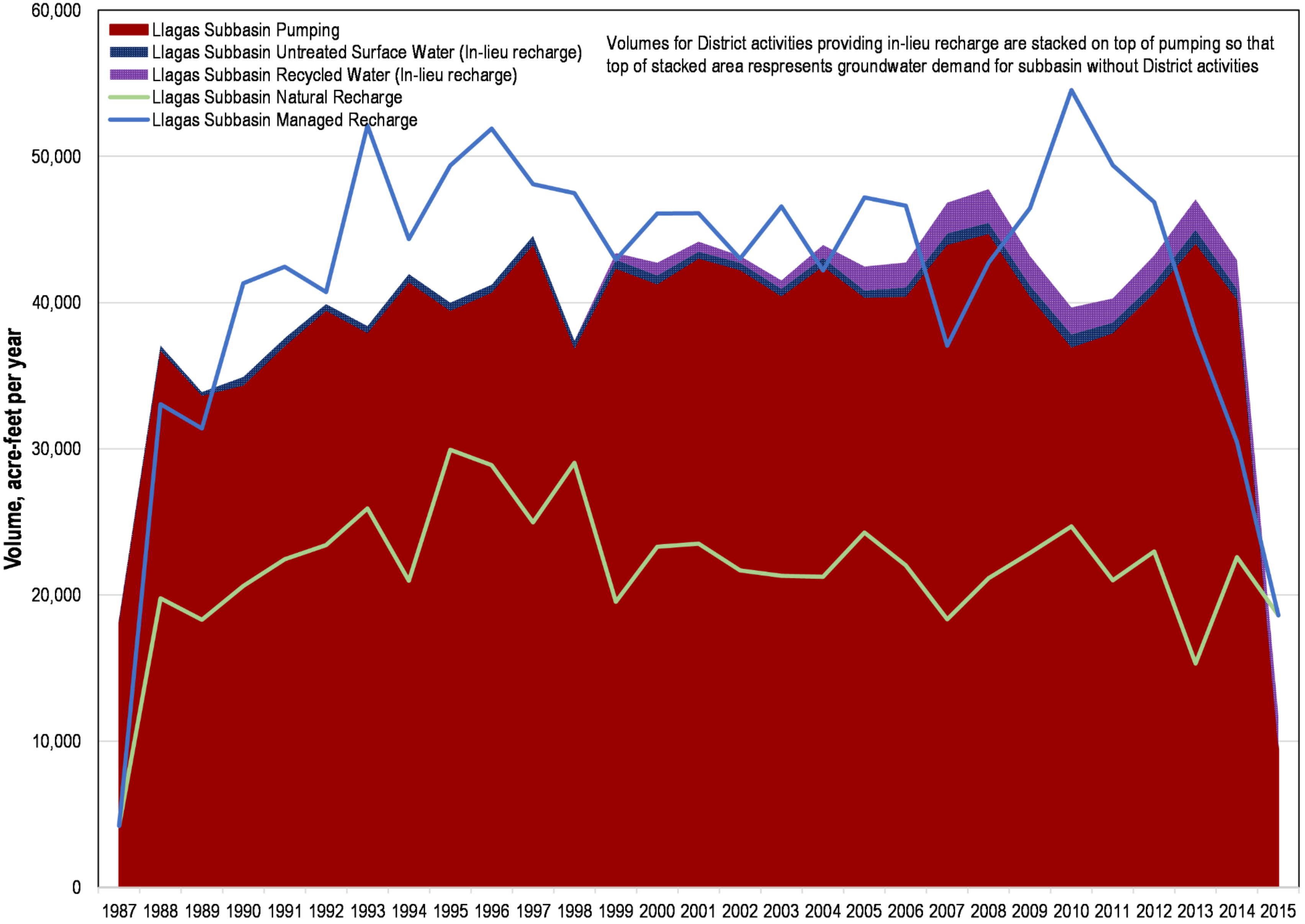


Figure 20. Llagas Subbasin Water Budget with District In-Lieu Recharge Activities

6.4 Application of Water Budget Evaluation to Analyses Supporting Groundwater Benefit Zones

The above summary provides a description of the general benefits to the water budgets of the potentially hydrogeologically connected areas of the Santa Clara Subbasin and the Llagas Subbasin. In order to support recommendation of groundwater benefit zones, groundwater level data evaluation and groundwater modeling is used to evaluate benefits in specific areas from specific District activities. In the groundwater level data evaluation, only specific time periods can be evaluated for benefits from District activities and benefits may not be evident in the evaluated periods due to factors such as decreasing precipitation and increasing pumping. The modeling scenarios evaluate District activities based on reducing the District activity over specific historical periods based on the availability of data. The water budget evaluation shows that the water budget benefit occurs for all periods since the District activities have commenced. Therefore, if benefits are demonstrated by groundwater level data or modeling over any period, it can be reasonably assumed that the benefit occurs over all periods while District activities are taking place.

7 MAPPING AND QUANTIFYING DISTRICT ACTIVITIES

7.1 Managed Aquifer Recharge

Locations of the District's managed aquifer recharge facilities are based on the files from the District's Geographic Information System (GIS) for recharge ponds and recharge streams supplemented by the National Hydrography Dataset (USGS, 2016).

For identification purposes, the recharge ponds and streams are grouped into systems consistent with District grouping: West Side, Los Gatos, Guadalupe, Coyote, Penitencia, Upper Llagas, and Lower Llagas recharge systems (SCVWD, 2016b). All systems but the Lower Llagas system are able to receive water from the State Water Project or Central Valley Project, and have the ability to recharge imported water as well as local runoff. The Lower Llagas system only recharges local runoff. Figure 21 shows the map of the recharge systems overlain on the basin geology.

Figure 21 shows that the managed recharge system creeks generally flow out of the bedrock areas into the alluvium. The West Side system flows over the Santa Clara Formation before flowing into the larger Unconsolidated Alluvium area. The Coyote system flows enters Unconsolidated Alluvium in Coyote Valley and flows north through Coyote Narrows into the Santa Clara Plain. The Lower Llagas system flows through the Unconsolidated Alluvium west of the bedrock outcrops into the Unconsolidated Alluvium in the Llagas Subbasin valley floor. All recharge ponds are located in the Unconsolidated Alluvium in the valley floor.

The District provided monthly recharge quantities for 1967-2014 by recharge facility for the West Side, Los Gatos, Guadalupe, Coyote, and Penitencia systems. The District provided annual recharge quantities from July 1987-2014 by recharge facility for the Upper Llagas and Lower Llagas systems. These data were aggregated into recharge quantities by water year and by system for the groundwater level data evaluation (Section 8).

The District operated these systems before records of recharge quantity data existed. The District compiled the operation start dates of recharge ponds from various sources. The Study evaluates benefits of managed recharge creeks beginning with construction of the upstream reservoirs. Table 1 shows the operation start date for each system is based on the first start date of any facility in the system.

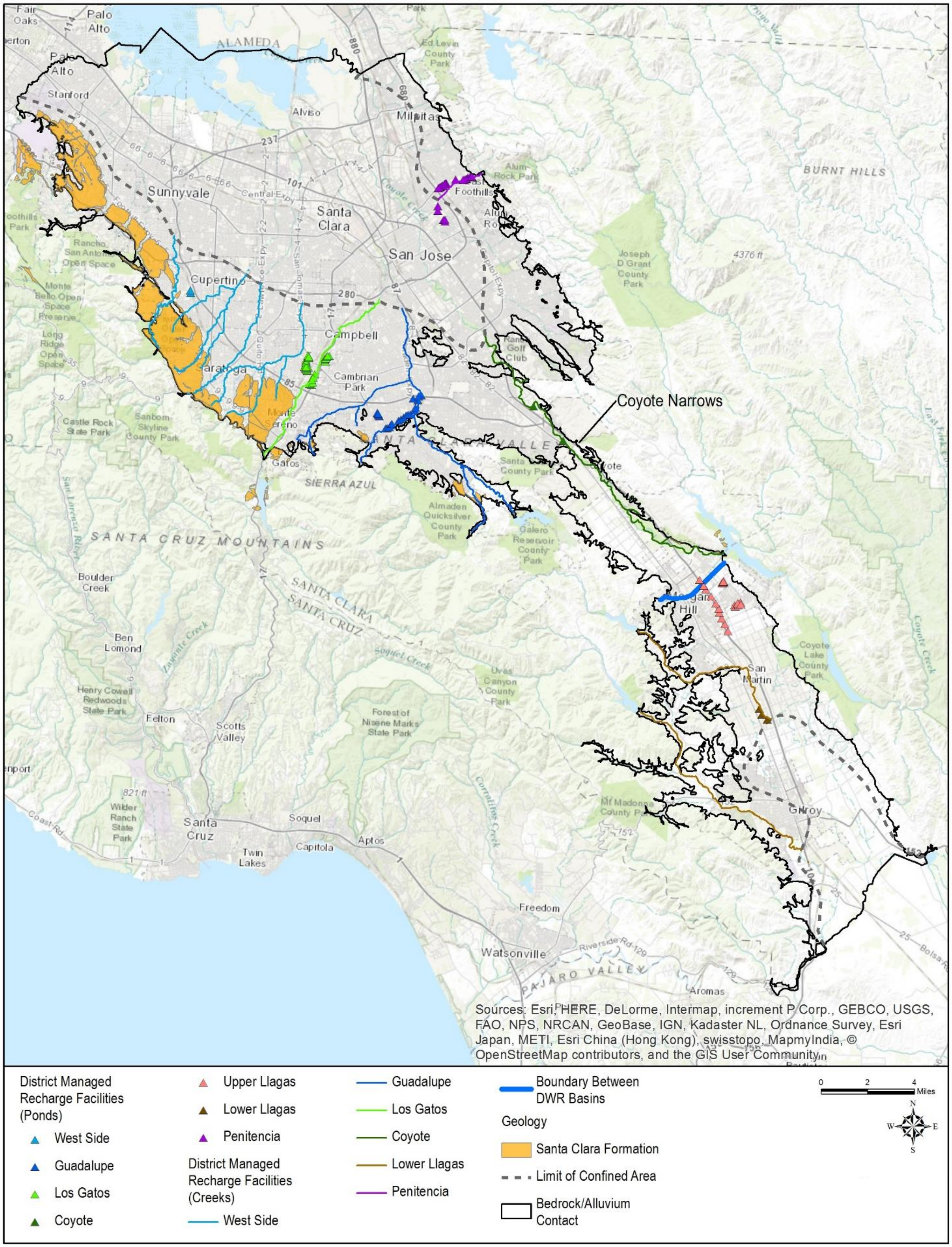


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Figure 21. District Managed Aquifer Recharge Systems

Table 1. Managed Recharge Start Dates

System	First Facility	Start Date	Reference
Coyote System	Coyote Percolation Ponds	1934	SCVWD, 1998
Guadalupe System	Alamitos Ponds	1932	SCVWD, 1998
Los Gatos System	Vasona Reservoir	1934	SCVWD, 2016b
Lower Llagas System	Chesbro Reservoir[1]	1955	SCVWD, 2016b
Penitencia System	Capital Ponds	1934	SCVWD, 2016b
Upper Llagas System	Main Ave. Ponds	1955	SCVWD, 1998
West Side System	Stevens Creek Reservoir	1935	SCVWD, 2016b

[1] Although Chesbro Reservoir was built for flood control, recharge benefits can be evaluated from the date of construction.

7.2 Treated Water Deliveries

The Study maps areas receiving District treated water to identify the source waters for different areas within retailer's service areas. Identification of areas receiving District treated water were based on the District's infrastructure reliability project technical memoranda on each retailer (SCVWD and AECOM, 2014a-j[1]), maps provided by the retailers, and Geographic Information System files provided by the retailers. Table 2 summarizes the references identifying these areas receiving District treated water and Figure 22 displays the treated water delivery areas overlain on the basin geology. Discussion of areas receiving other sources of water is provided in Section 8.1.2.1.

Table 2. Areas Receiving District Treated Water

Retailer	Zone/Area Identified	GIS Source
Cal Water	Cupertino, Southwest of Foothill Expressway	SCVWD and AECOM, 2014e
Mountain View	Zone 3 (area west of Hwy 85 and approximately south of Cuesta Dr.)	City of Mountain View, 2005
Milpitas	Zones SC1 (West of I-880) and SC2 (South of Calaveras Blvd and west of I-680)	City of Milpitas, 2015
Santa Clara	Zones II and IIA (approximately south of Benton St.)	City of Santa Clara, 2012
Sunnyvale	Zones II and III (approximately El Camino Real and south)	SCVWD and AECOM, 2014b
San Jose Municipal	Evergreen	San Jose Municipal system map
San Jose Water Co.	San Jose, Cupertino, Saratoga, Campbell	San Jose Water Company GIS, 2016

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[1] These reports are confidential, but information on delivery areas is not confidential.

Figure 22 shows that treated water delivery areas are located primarily in Unconsolidated Alluvium in the Santa Clara Plain north of Coyote Narrows, but also overlap the Santa Clara Formation and bedrock. Groundwater users in all of these areas receiving District treated water benefit from the in-lieu recharge occurring in these areas. The Los Altos area of Cal Water receiving District treated water overlies the Santa Clara Formation with the Foothill Expressway boundary of this area approximately coincident with the eastern extent of the Santa Clara Formation. The Cupertino and West areas of San Jose Water Company also partially overlie the Santa Clara Formation. Even in bedrock, groundwater users benefit from neighbors receiving treated water as this in-lieu recharge reduces demand for limited supplies in bedrock fractures.

The District provided monthly quantities of treated water deliveries to each retailer for 1967-2015. These data were aggregated into delivery quantities by water year and by retailer for the groundwater level data evaluation (Section 8). The sum of individual retailer quantities for Water Years 1970-1973 were over 25% short of quantities for total treated water deliveries so retailer quantities for these years were proportionally increased to match the totals.

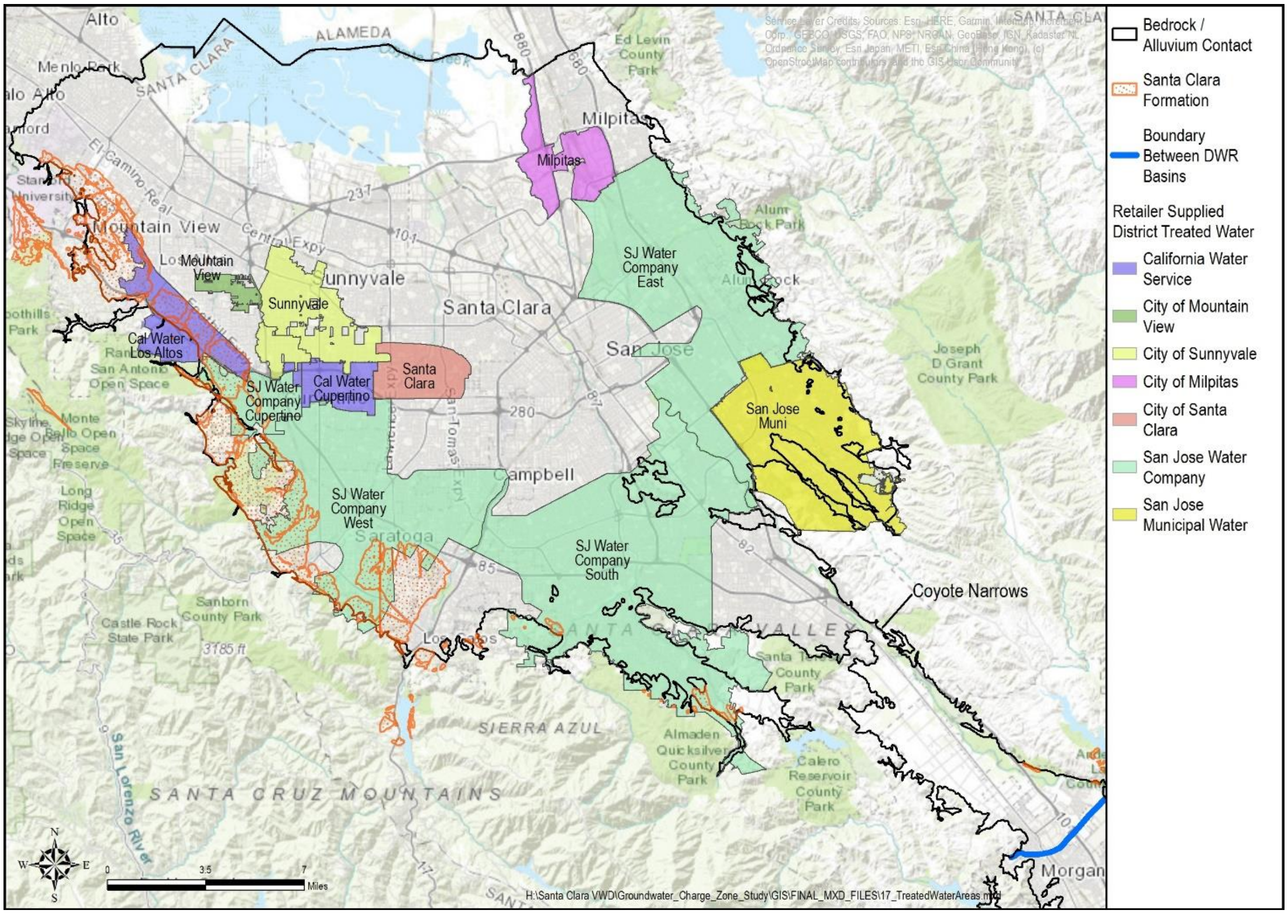


Figure 22. Retailer Areas Receiving District Treated Water Deliveries

7.3 Recycled Water

Mapping of recycled water deliveries is based on GIS files provided by the District of pipeline alignments for the four recycled water systems: Palo Alto, Sunnyvale, South Bay Water Recycling Program and South County Regional Wastewater Authority. Figure 23 shows the pipelines overlying geology.

The Palo Alto and Sunnyvale systems overlie Unconsolidated Alluvium in the Santa Clara Plain. The South Bay Water Recycling Program system mostly overlies Unconsolidated Alluvium in the Santa Clara Plain, but also overlies some bedrock areas to the southeast and extends a short distance across Coyote Narrows into Coyote Valley. The South County Regional Wastewater Authority system overlies Unconsolidated Alluvium deposits in the Llagas Subbasin in Gilroy and east of Gilroy.

The District provided monthly quantities of recycled water deliveries from 1998-2015 for each of the four systems, including deliveries from the District's Silicon Valley Advanced Water Purification Center via the South Bay Water Recycling Program system. Figure 19 and Figure 20 are based on these data aggregated into delivery quantities by water year and by system. However, as shown by Figure 19 and Figure 20, these deliveries are a relatively small part of the overall budget and therefore the effect is not expected to be observed in the groundwater level evaluation. Existing pipelines (Figure 23) will need to be extended to deliver purified water for planned indirect potable reuse projects. The District is still in process of evaluating those plans.

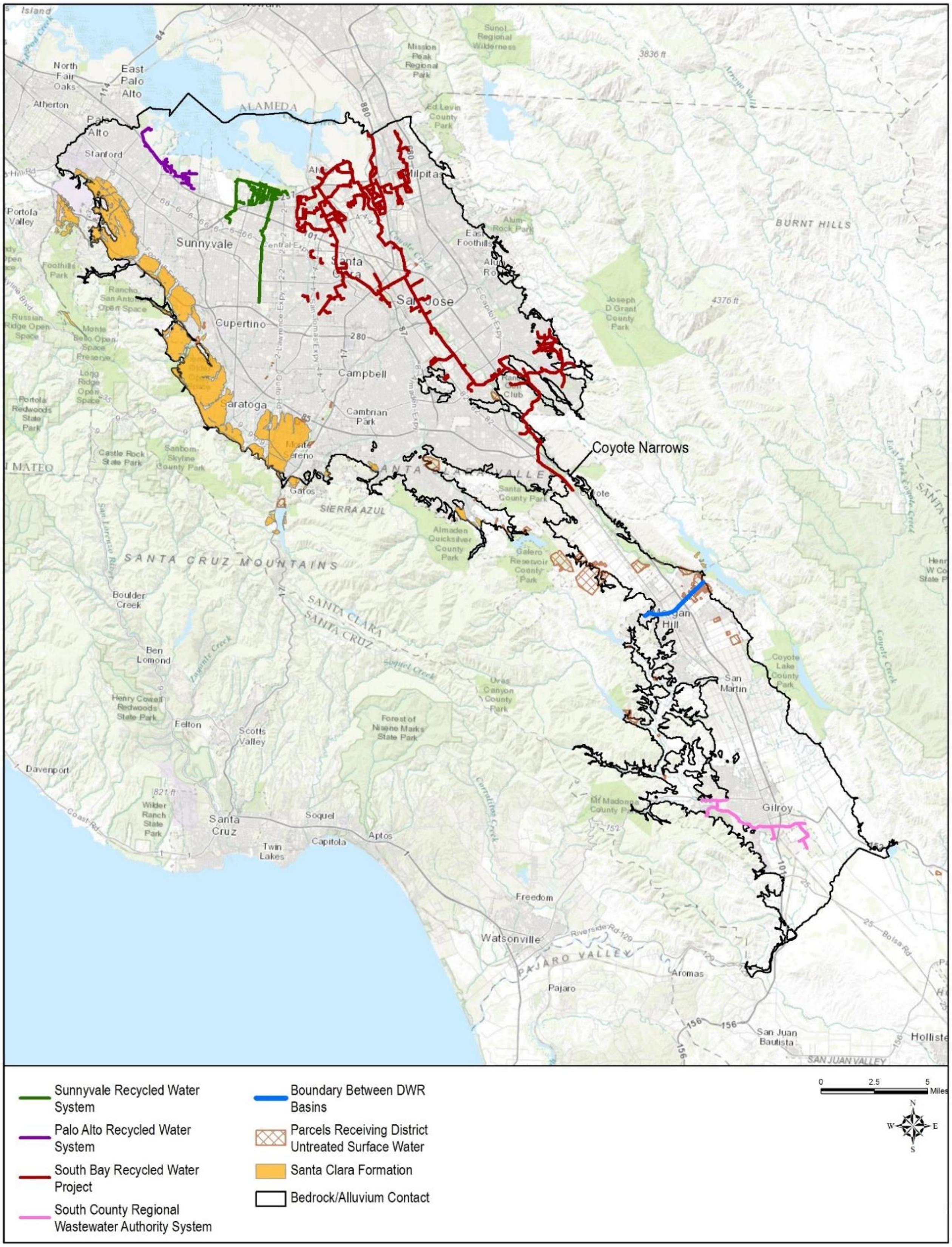


Figure 23. Recycled Water Systems and Parcels Receiving District Untreated Surface Water

7.4 Surface Water Deliveries

Mapping of the District's untreated surface water deliveries is based on District's data of parcels receiving deliveries and County GIS files of parcels. Figure 23 shows locations of parcels that have received surface water deliveries from fiscal years 2010-2015, overlain on the basin geology.

Parcels receiving untreated surface water deliveries overlie Unconsolidated Alluvium in the Santa Clara Plain, Coyote Valley, and Llagas Subbasin both west and east of bedrock outcrops in that subbasin. There are also parcels receiving untreated surface water deliveries in bedrock.

The District provided semi-annual quantities of surface water deliveries. Data are available by existing groundwater benefit zone prior to fiscal year 2010 and by parcel since fiscal year 2010. Data for zone W-2 commence in 1981 while data for zone W-5 commence in 1987. Figure 19 and Figure 20 are based on these data aggregated into annual delivery quantities by existing groundwater benefit zone. However, Figure 19 and Figure 20 show that these deliveries are a relatively small part of the overall budget and therefore the effect is not expected to be observed in the groundwater level evaluation. Also, surface water delivery areas are parcel based so groundwater users on a parcel are assumed to be the same as the surface water customer for the parcel. Therefore, there are no other groundwater users in the surface water delivery areas that receive in-lieu benefits from surface water delivery areas.

7.5 Conservation Activities

Conservation provides in-lieu recharge benefits to groundwater users by reducing the amount of groundwater pumped. Conservation activities occur throughout the District so groundwater users throughout the District receive in-lieu benefits. Figure 24 shows a map of parcels receiving different conservation rebates to demonstrate the widespread nature of the conservation activities. However, the disperse nature of conservation and its variable application is expected to make it difficult to be observed in the groundwater level evaluation. In addition, the rebates are equally available throughout the District so benefits are available throughout the District. Therefore, conservation activities are not used to define groundwater benefit zones.

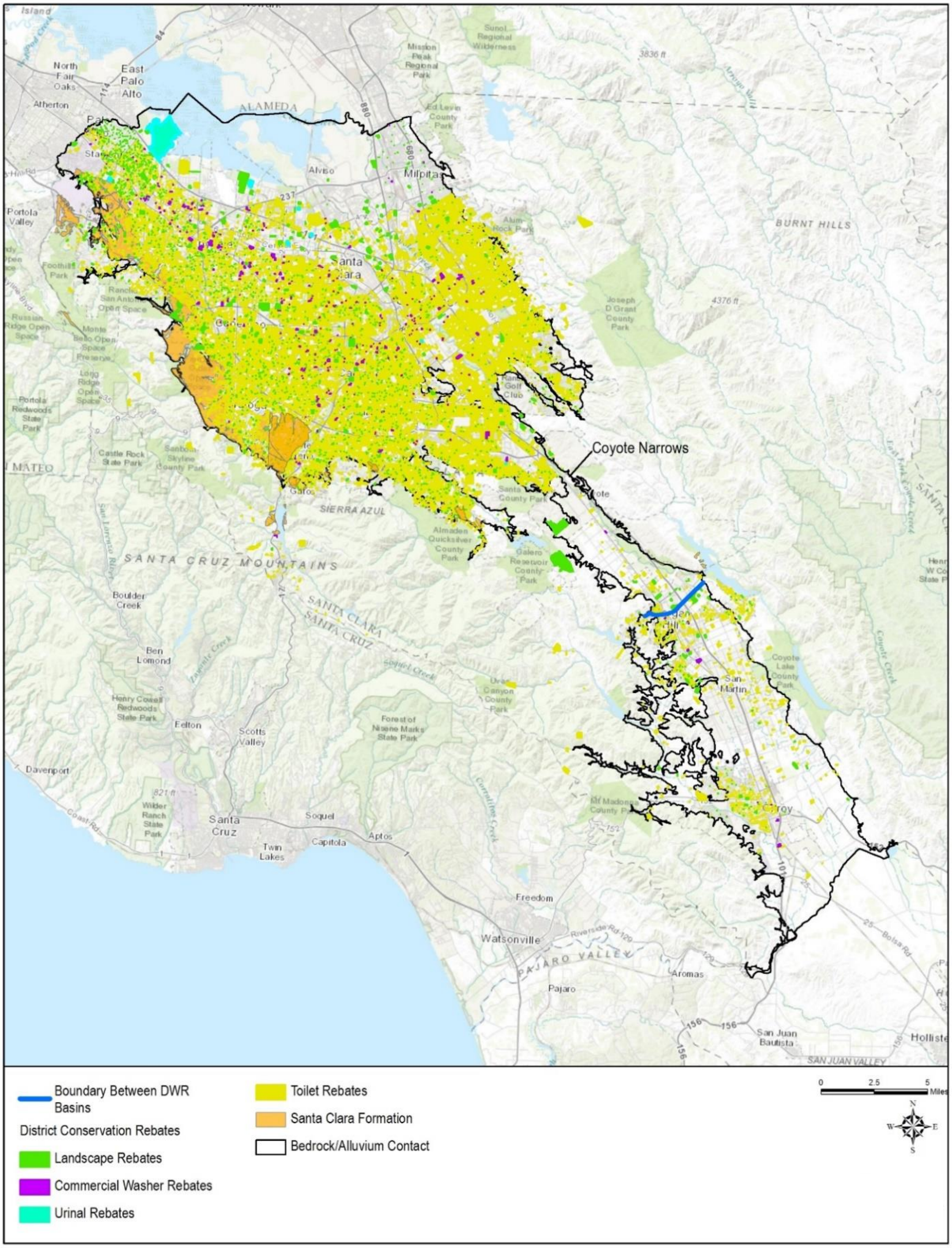


Figure 24. Parcels Receiving Conservation Rebates

8 GROUNDWATER LEVEL DATA EVALUATION

As described in the methodology memo, the Study uses groundwater level data to evaluate areas where groundwater users benefit from District deliveries of treated water and areas where groundwater users benefit from District managed aquifer recharge activities. This evaluation follows two basic steps:

1. Identify periods for evaluating benefits from District recharge activities based on groundwater level trends (evaluation periods). Evaluation periods are chosen based on two criteria:
    a. Climatic conditions and area pumping during these periods would result in an expected decreasing groundwater level trend if no District activity occurred.
    b. These periods show active and stable or increasing District in-lieu or managed recharge during the periods such that a stable or increasing groundwater trend during the period can be attributed to the District activity.
2. During these evaluation periods, evaluate whether observed groundwater level data in the area show a stable or increasing trend demonstrating a benefit from the District activity. If the benefit from District activities is demonstrated in one evaluation period, it is considered to occur as long as the District activity is taking place:
    a. Section 6 shows District activities have been providing benefit to the water budget for all periods, whether or not they meet evaluation criteria.
    b. Evaluation periods are periods of expected declining groundwater. If during these periods groundwater levels are stable or increasing, the benefit of the District activity is demonstrated. The benefit from the District activity is not demonstrated if declining groundwater levels are observed, but this also does not indicate lack of benefit from District activities as the District activity may still be benefitting by limiting the decline in groundwater levels.

8.1 Identify Periods for Evaluation

The three factors used to identify evaluation periods are rainfall, area pumping, and quantities of treated water delivery and managed aquifer recharge provided by the District activities. Without a District activity, we expect groundwater level trends to decrease if rainfall is decreasing and/or pumping is increasing. The expectation is groundwater level trends would also decrease if rainfall is decreasing or pumping is increasing while the other factor is stable. In order to attribute an increasing groundwater level trend to either the District's treated water or managed recharge activity during evaluation periods, the quantities provided by the District activity needs to be stable or increasing. Decreasing groundwater level trends are likely to be observed in many evaluation periods even with benefits from District activities occurring due to the rainfall and area pumping conditions.

8.1.1 Rainfall

Rainfall at the City of San Jose gauge station ID 6131 of the ALERT hydrologic data collection system (ALERT ID 1453) is representative of changes to climatic conditions within the District's Subbasins. Annual water year rainfall totals from 1932-2013 are used to calculate the cumulative departure from the mean annual rainfall (Figure 25). Periods when the cumulative departure is stable or declining meet the criteria for evaluation periods.

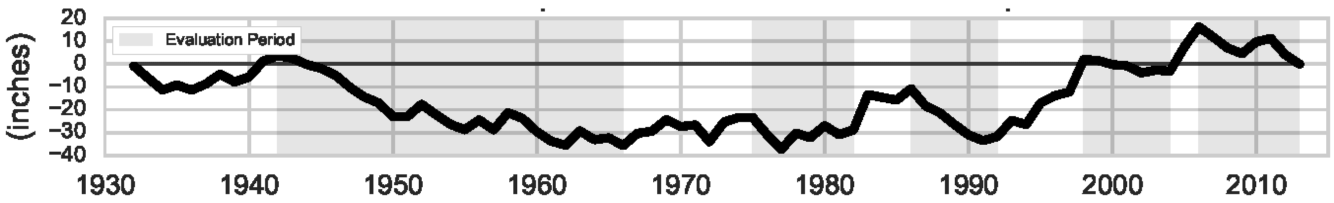


Figure 25. Cumulative Departure of Mean Annual Rainfall

8.1.2 Area Pumping

In order to identify evaluation periods, the Study totals pumping for each retailer and non-retailer area distinguished by water source. In other words, a retailer's service area is divided into multiple pumping areas if the retailer delivers different water sources to different areas. These pumping areas are used because the availability of surface water such as District treated water, Regional Water System (RWS) or San Jose Water Company's surface water derived from its own water right affects pumping demand for the area. Appendices C-F and example figures, **Error! Reference source not found.**Figure 29 through Figure 36, include the aggregated groundwater pumping by pumping area over time.

This approach ensures that the groundwater level data evaluation accounts for the effects of in-lieu recharge by non-District deliveries. Therefore, a benefit from any non-District in-lieu recharge such as SFPUC RWS deliveries or San Jose Water Company's surface water will not be misattributed to a District activity.

In addition, the evaluation of benefits from the District managed recharge activity also accounts for the effects of in-lieu recharge by District deliveries of treated water. Even with in-lieu recharge sources for an area, if pumping is increasing while rainfall is stable or decreasing, the expected groundwater level trend is still decreasing. The in-lieu recharge may have reduced the expected decrease in groundwater level trend but a stable or increasing groundwater level trend concurrent with stable or increasing quantities from a District activity would demonstrate a benefit from that District activity. Likewise, in-lieu recharge may result in stable pumping, including zero or near-zero pumping, in an area, but expected groundwater level trend is decreasing if rainfall is decreasing. Thus, the Study seeks to compare anticipated outcomes with no District activity with actual outcomes and recognizes benefits from District activities if the actual outcome reflects an improvement over anticipated outcomes.

8.1.2.1 Mapping Retailer and Non-Retailer Areas by Water Source

Retailer areas receiving District treated water are mapped as described in Section 7.2. Groundwater users in all of these areas receiving District treated water benefit from in-lieu recharge so the groundwater level trend evaluation only assessed benefits from managed recharge in these areas. The groundwater level trends were used to evaluate benefits from both managed recharged and treated water deliveries in areas not receiving District treated water.

In addition to mapping retailer areas receiving treated water as discussed in Section 7.2, the Study maps retailer areas receiving water from San Francisco Public Utilities Commission's RWS supplies and San Jose Water Company's surface water. The Study also maps areas supplied only by groundwater.

As with mapping areas receiving treated water, the references used to identify areas receiving different sources were the District's infrastructure reliability project technical memoranda on each retailer, maps provided by the retailers, and Geographic Information System files provided by the retailers. Table 3 summarizes the mapped areas.

These areas also are used to summarize pumping because the availability of different sources of water for each area presumably affects groundwater demand in that area. To facilitate these areal pumping summaries, the large area of San Jose Water Company serving primarily District treated water was divided into three areas based on District managed recharge creeks. The west area is the area west of Los Gatos Creek. The south area is the area between Los Gatos and Coyote Creek. The east area is the area east of Coyote Creek.

In addition, non-retailer areas are identified to facilitate areal pumping summaries. North Morgan Hill is the non-retailer area between Morgan Hill and San Jose. Eastern Llagas is the non-retailer area east of Morgan Hill, Gilroy, and the bedrock outcrops in the Llagas Subbasin identified on Figure 13. Uvas-Chesbro is the non-retailer area downstream of the District's Uvas and Chesbro Reservoirs west of Morgan Hill, Gilroy, and the bedrock outcrops in Llagas Subbasin identified on Figure 13. Figure 26, Figure 27, and Figure 28 the pumping areas in Santa Clara Plain, Coyote Valley, and Llagas Subbasin, respectively.

Table 3. Summary of Pumping Areas and Non-District Treated Water Supplies

Retailer	Water Supply Source	Zone/Area Identified	GIS Source
Cal Water	Groundwater	Sunnyvale, Mountain View	City of Mountain View, 2008
Gilroy	Groundwater	All	SCVWD GIS for Retailer Sources
Great Oaks	Groundwater	All	Great Oaks PUC Grid
Milpitas	SFPUC	Zones SF1-4(northeast of I-880 and Calaveras Rd., east of I-680, between I-880, S. Main St, and approximately Great Mall Pkwy)	City of Milpitas, 2015
Mountain View	Groundwater and SFPUC	Zone 1 and 2 (approximately north of Cuesta Dr. and east of Hwy 85)	City of Mountain View, 2005 and 2008
Morgan Hill	Groundwater	All	SCVWD GIS
NASA Ames	SFPUC	All	SCVWD GIS
Palo Alto	SFPUC	All	SCVWD GIS
Santa Clara	Groundwater	Zone I and Zone II and IIA (approximately south of Central Expressway)[1]	City of Santa Clara, 2012
	Groundwater and SFPUC	Zone I and IA (approximately north of US 101)	
Sunnyvale	Groundwater	All (blended)	SCVWD and AECOM, 2014b
	SFPUC	Zone I (approximately north of El Camino Real)	
San Jose Municipal	Groundwater	Edenvale and Coyote	San Jose Municipal system map
	SFPUC	Alviso	
San Jose Water Co.	Groundwater	San Jose (north) Cupertino (with SCVWD Treated Water)	San Jose Water Company GIS, 2016
	Local Surface Water Right	Saratoga, Los Gatos	
Stanford	SFPUC	All	SCVWD GIS

[1] Parts of City of Santa Clara Zones II and IIA also receive SCVWD treated water deliveries that is blended with groundwater.

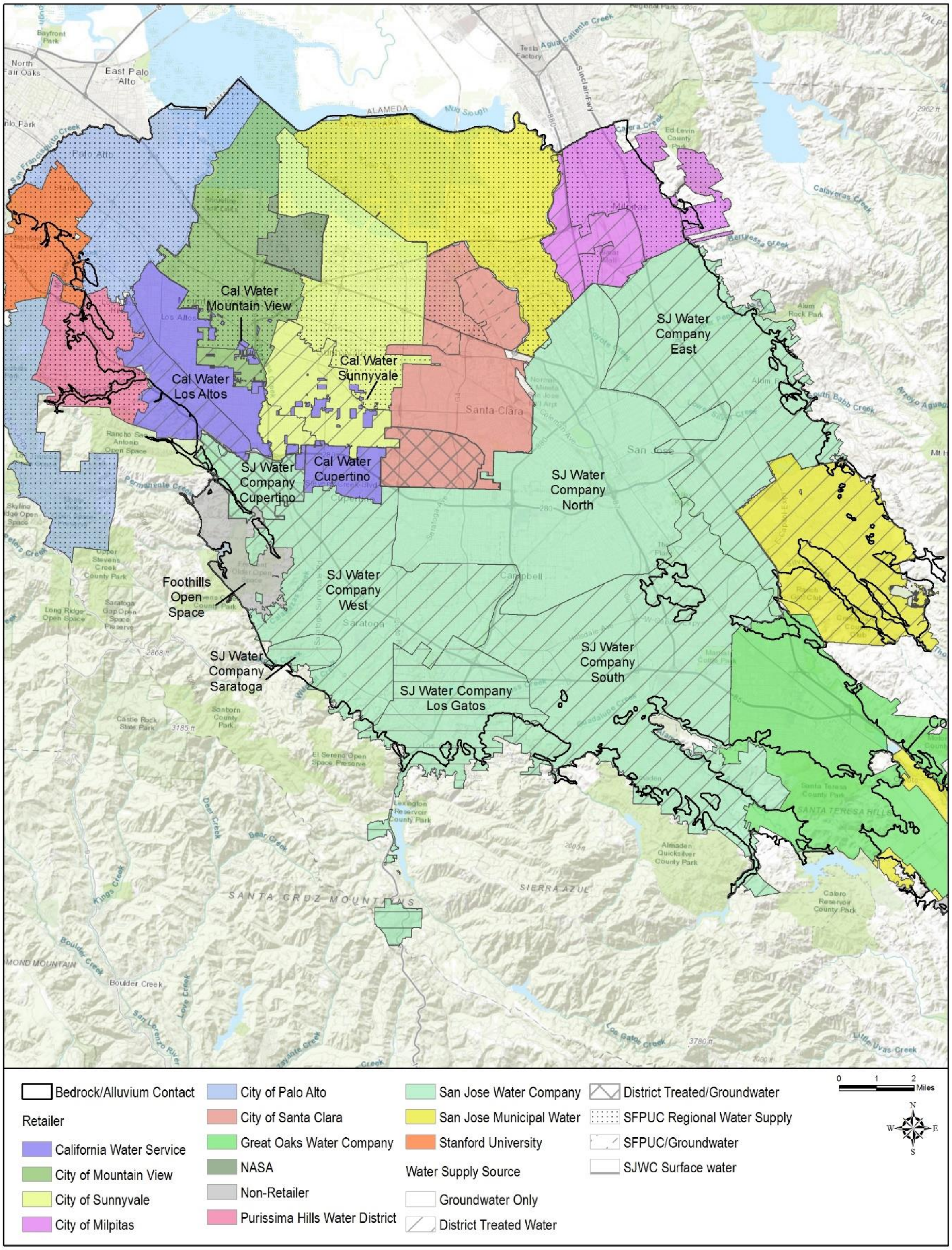


Figure 26. Pumping Areas in Santa Clara Plain

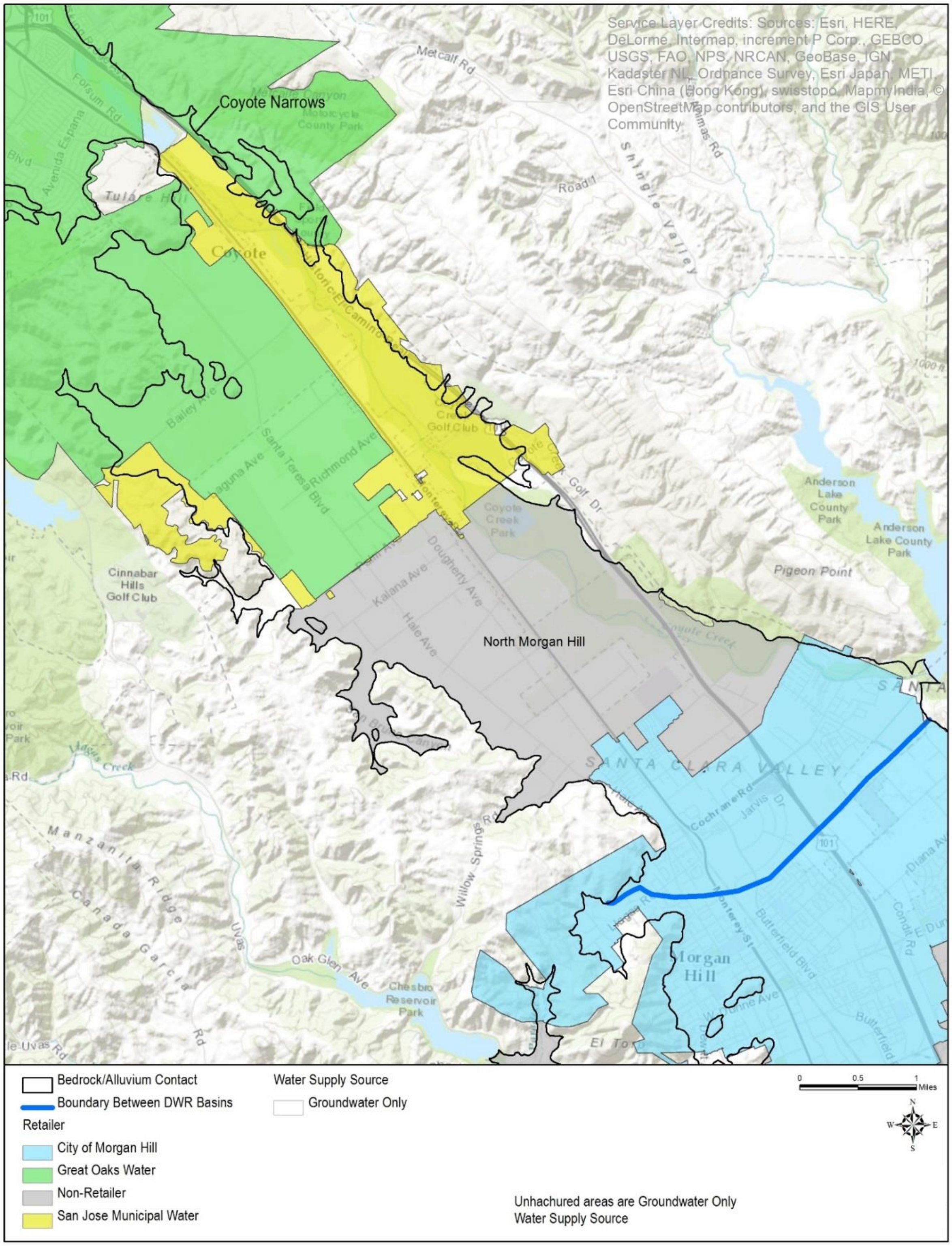

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Coyote Narrows
North Morgan Hill
Coyote
Morgan Hill
SANTA CLARA VALLEY
Bedrock/Alluvium Contact
Boundary Between DWR Basins
Retailer
City of Morgan Hill
Great Oaks Water
Non-Retailer
San Jose Municipal Water
Water Supply Source
Groundwater Only
Unhachured areas are Groundwater Only Water Supply Source
0
0.5
1
Miles
N
S
E
W

Figure 27. Pumping Areas in Coyote Valley

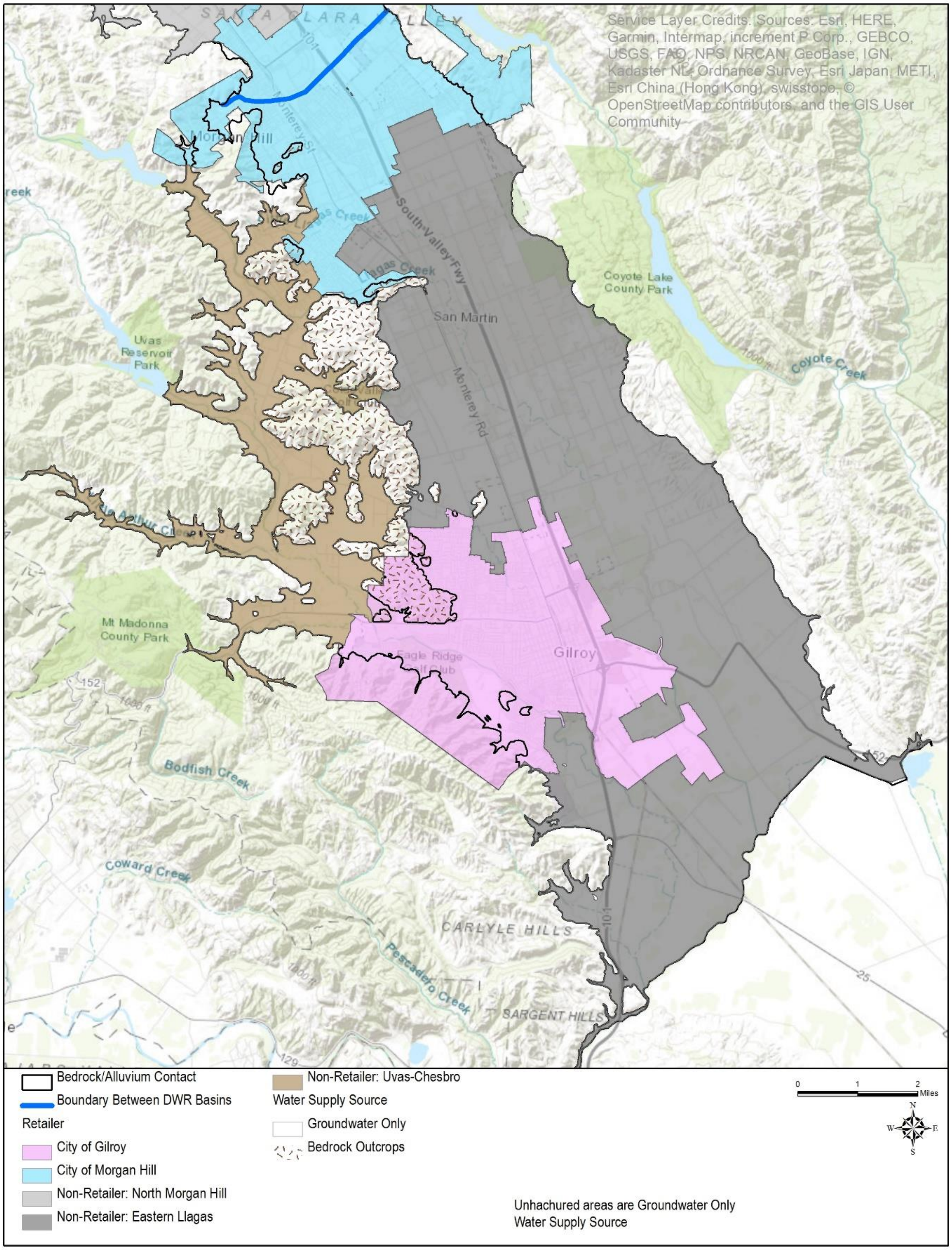

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
SANTA CLARA VALLEY
Morgan Hill
Monterey St
South Valley Fwy
Llagas Creek
San Martin
Monterey Rd
Coyote Lake County Park
Coyote Creek
Uvas Reservoir Park
Uvas Creek
Mt Madonna County Park
Gilroy
Eagle Ridge Golf Club
Bodfish Creek
Coward Creek
Pescadero Creek
CARLYLE HILLS
SARGENT HILLS
101
152
129
25
1000 ft
Bedrock/Alluvium Contact
Boundary Between DWR Basins
Retailer
City of Gilroy
City of Morgan Hill
Non-Retailer: North Morgan Hill
Non-Retailer: Eastern Llagas
Non-Retailer: Uvas-Chesbro
Water Supply Source
Groundwater Only
Bedrock Outcrops
0
1
2
Miles
N
E
S
W
Unhachured areas are Groundwater Only Water Supply Source

Figure 28. Pumping Areas in Llagas Subbasin

8.1.2.2 Distribution of Groundwater Deliveries

One consideration with retailer areas is whether retailers deliver groundwater supplies across potential boundaries for hydrogeologically connected areas such as the Coyote Narrows, DWR basin boundary between the Santa Clara and Llagas Subbasins, between the Santa Clara Formation and Unconsolidated Alluvium areas of the Santa Clara Plain, and through constrictions of bedrock outcrops in the Llagas. This could result in groundwater benefits from District activities in one hydrogeologically connected area extending to a different hydrogeologically connected area. Retailer delivery of groundwater supplies from a hydrogeologically connected area into bedrock is not considered to extend groundwater benefits into bedrock because the delivery of groundwater across the well-defined boundary of hydrogeologic connection is not considered a District activity.

Groundwater pumped in Unconsolidated Alluvium of the Santa Clara Plain is delivered to the Cupertino area of San Jose Water Company overlying the Santa Clara Formation. However, the boundary between hydrogeologically connected areas is well defined by the outcrop of the Santa Clara Formation and the delivery of groundwater across that boundary is not considered a District activity. Therefore, this does not result in groundwater benefits from District activities in the Unconsolidated Alluvium of the Santa Clara Plain extending into the Santa Clara Formation.

The San Jose Municipal Water System only pumps and delivers groundwater for the Edenvale area north of Coyote Narrows in Santa Clara Plain and for its Coyote area south of Coyote Narrows in Coyote Valley. However, San Jose Municipal Water System does not pump groundwater and deliver it across Coyote Narrows into the other management area.

Great Oaks Water Company pumps and delivers groundwater on both sides of the Coyote Narrows in the Santa Clara Plain and Coyote Valley. Great Oaks pumps groundwater in Coyote Valley for delivery to the Santa Clara Plain, but the reverse does not occur. District managed aquifer recharge activity occurs in both Coyote Valley and Santa Clara Plain, so this delivery does not alter the area benefiting from managed aquifer recharge.

Morgan Hill straddles the DWR basin boundary representing the groundwater divide between Coyote Valley and Llagas Subbasin. If Morgan Hill’s pumping distribution changed enough to substantially move the location of the average groundwater divide, the areas considered hydrogeologically connected would be subject to revision.

Morgan Hill and Gilroy are primarily overlying the Unconsolidated Alluvium east of the bedrock outcrops (valley floor) in the Llagas Subbasin, but the western service area boundaries approach or extend into the Unconsolidated Alluvium west of the bedrock outcrop. The boundary between separate hydrogeologic areas defined by bedrock outcrops are not well defined in these areas and delivery of groundwater in the Morgan Hill and Gilroy areas help define the areas with demonstrated benefits.

8.1.2.3 Pumping Quantities

The District provided annual pumping data by well for calendar years 1981-2015 in existing Zone W-2 and 1987-2015 in existing Zone W-5. The Study identifies the pumping area for each well location and the pumping subplots in Appendices C- F and example figures,**Error! Reference source not found.**Figure 29 through Figure 38, show total annual pumping aggregated for each area.

Pumping data by well are not available prior to 1981, but recorded pumping is included in the Santa Clara Plain groundwater model for 1970-1980. The pumping subplots in Appendices C and D show modeled pumping aggregated for each of the pumping areas in the Santa Clara Plain.

Some of the pumping subplots in Appendices C-F and example figures, Figure 29 through Figure 38 also plot population for the city of the area or Census Designated Population (CDP) to evaluate likely changes in pumping demand before pumping data or estimates are available. Population increases indicate likely increase in pumping demand. However, when non-District sources of supply such as SFPUC Regional Water System or San Jose Water Company surface water become available to an area, population no longer represents a proxy for pumping demand. Therefore, the pumping subplots display milestone dates for the availability of these supplies (Walker and Williamson, 1983).

8.1.3 District Activity

The District activity subplots in Appendices C-F and example figures, Figure 29 through Figure 38, show quantities of managed recharge and treated water deliveries in the potentially hydrogeologically connected areas of the Santa Clara and Llagas Subbasins. The closest system activity to the pumping area being evaluated is plotted at the bottom with the quantities of other systems stacked based on distance. The plots for managed recharge show the start date of managed recharge systems as shown in Table 1. Prior to recharge quantity data being available, the operation of managed recharge is assumed to result in stable or increasing quantities. Evaluation periods that meet conditions for rainfall, pumping, and the District activity are identified with grey shading.

For the Santa Clara Subbasin including the Santa Clara Plain and Coyote Valley, the Study evaluates treated water deliveries (Appendix C) and managed recharge (Appendix D) separately. The Study does not evaluate managed recharge of imported water separately from managed recharge of local runoff because all managed recharge systems in Santa Clara Subbasin are connected to imported water supplies. Therefore, groundwater users that benefit from managed recharge systems in the Santa Clara Subbasin benefit from imported water supplies as well as capture of local runoff.

For the Llagas Subbasin, the Study evaluates managed recharge (Appendix E). The subplots on Appendix E plot managed recharge from the Upper Llagas and Lower Llagas systems separately based on distance from each pumping area, but the Study evaluates the systems together. The Upper Llagas system recharges both local runoff and imported water so it is not possible to evaluate the effects of recharging the two sources separately. Unlike the Upper Llagas system, the Lower Llagas system recharges only local runoff, periods when recharge in only one of the two systems is increasing were too short to evaluate the benefit from only that system. Therefore, the groundwater level evaluation is unable to distinguish between benefits from local runoff and benefits from imported water for groundwater users that benefit from managed recharge systems in the Llagas Subbasin.

Periods that have stable or increasing District managed recharge or treated water in the potentially hydrogeologically connected areas that line up with necessary rainfall and pumping conditions to evaluate are identified by the shading on the plots.

In the Santa Clara Subbasin, several periods were evaluated for both treated water and managed recharge because quantities for both activities were stable or increasing during a period with necessary rainfall and pumping conditions. Groundwater level improvements in areas during these overlapping periods demonstrate benefits from the District activities for those activities. However, groundwater level improvements can only be attributed to a specific activity if one activity increased during the overlapping period while the other activity was stable and groundwater level trends increased. As a result, the benefit demonstrated by increasing groundwater level trend can be attributed to the increasing activity. Otherwise, benefits cannot be attributed to a specific activity.

8.2 Area Groundwater Level Trends During Evaluation Periods

In Appendices C-F, plots of groundwater level data by area stacked with the plots of rainfall, pumping by area, District activity quantities are shown with the shaded evaluation periods identified. If the plotted groundwater level trends during the shaded periods are stable or increasing, a benefit from a District activity during that period is demonstrated.

8.2.1 Monitoring Well Groundwater Level Trends by Area

For each pumping area, Appendices C-E present plots of static groundwater levels from monitoring wells over time. The monitoring wells are identified as wells that do not have groundwater pumping data so may include wells constructed as water supply wells. To evaluate whether treated water deliveries or managed recharge demonstrates benefits in the area, the Study evaluates groundwater level trends in the pumping area for each evaluation period. The Study evaluates trends based on groundwater levels from all the monitoring wells in the area because benefits to the area, not any specific well, is the criteria for establishing groundwater benefit zones. Example figures from Appendices C-E are shown in Figure 29 for managed recharge in the Santa Clara Subbasin, Figure 30 for treated water in the Santa Clara Subbasin, and Figure 31 for managed recharge in the Llagas Subbasin. The shaded periods are the evaluation periods when groundwater level trends in the bottom plot are evaluated. If the plotted groundwater level trends during the shaded periods are stable or increasing, a benefit from a District activity during that period is demonstrated. The benefit is then assumed to occur as long as the District activity is taking place and has not changed significantly.

Table 4 summarizes the evaluation of managed recharge in the Santa Clara Subbasin corresponding to plots in Appendix C. Table 5 summarizes the evaluation of treated water deliveries corresponding to plots in Appendix D. Table 6 summarizes the evaluation of managed recharge in the Llagas Subbasin corresponding to plots in Appendix E. Most of the pumping areas evaluated have data that demonstrate benefits from each evaluated activity.

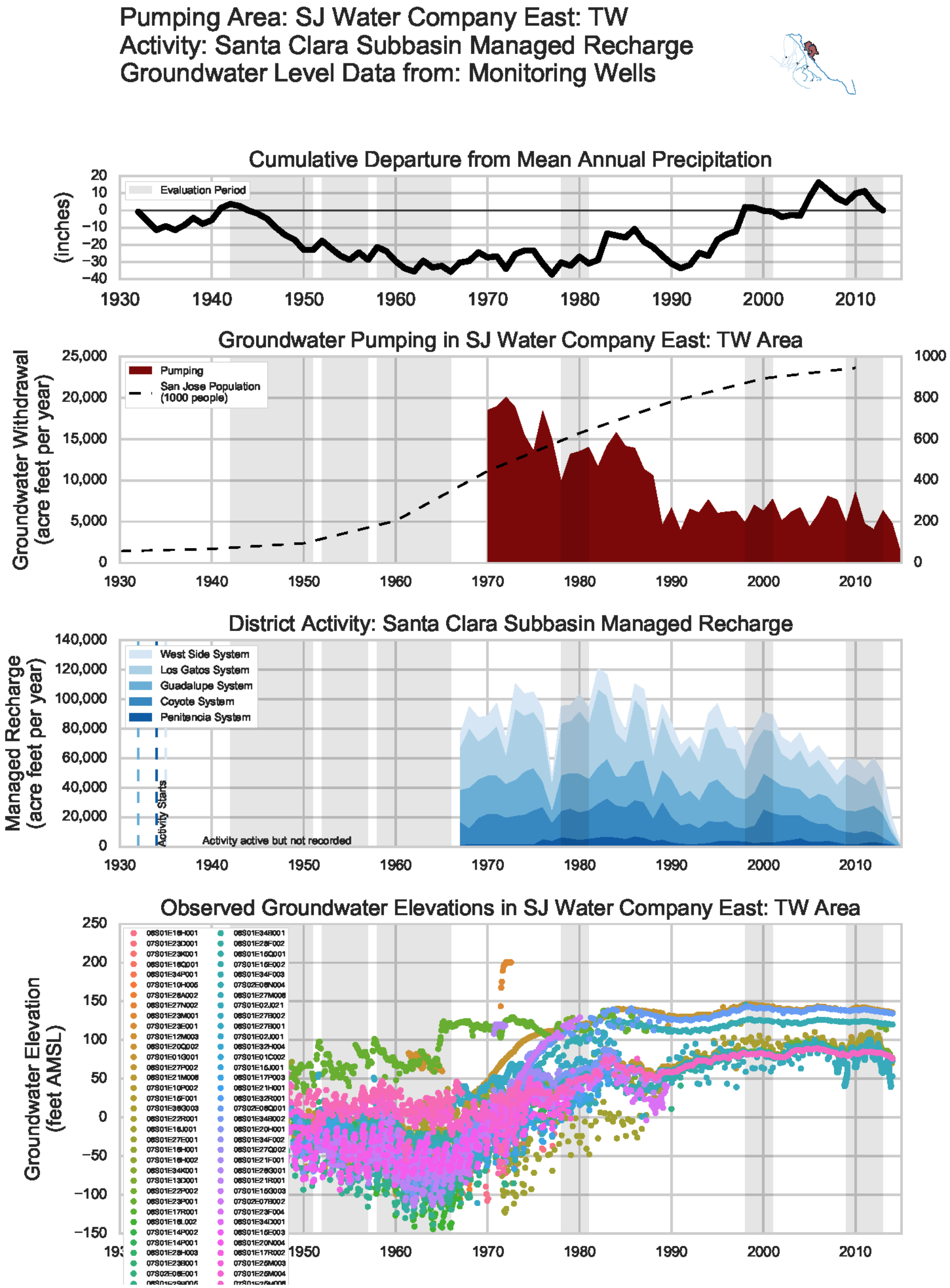


Figure 29. Example of Monitoring Well Groundwater Level Trend Evaluation of Managed Recharge in the Santa Clara Subbasin

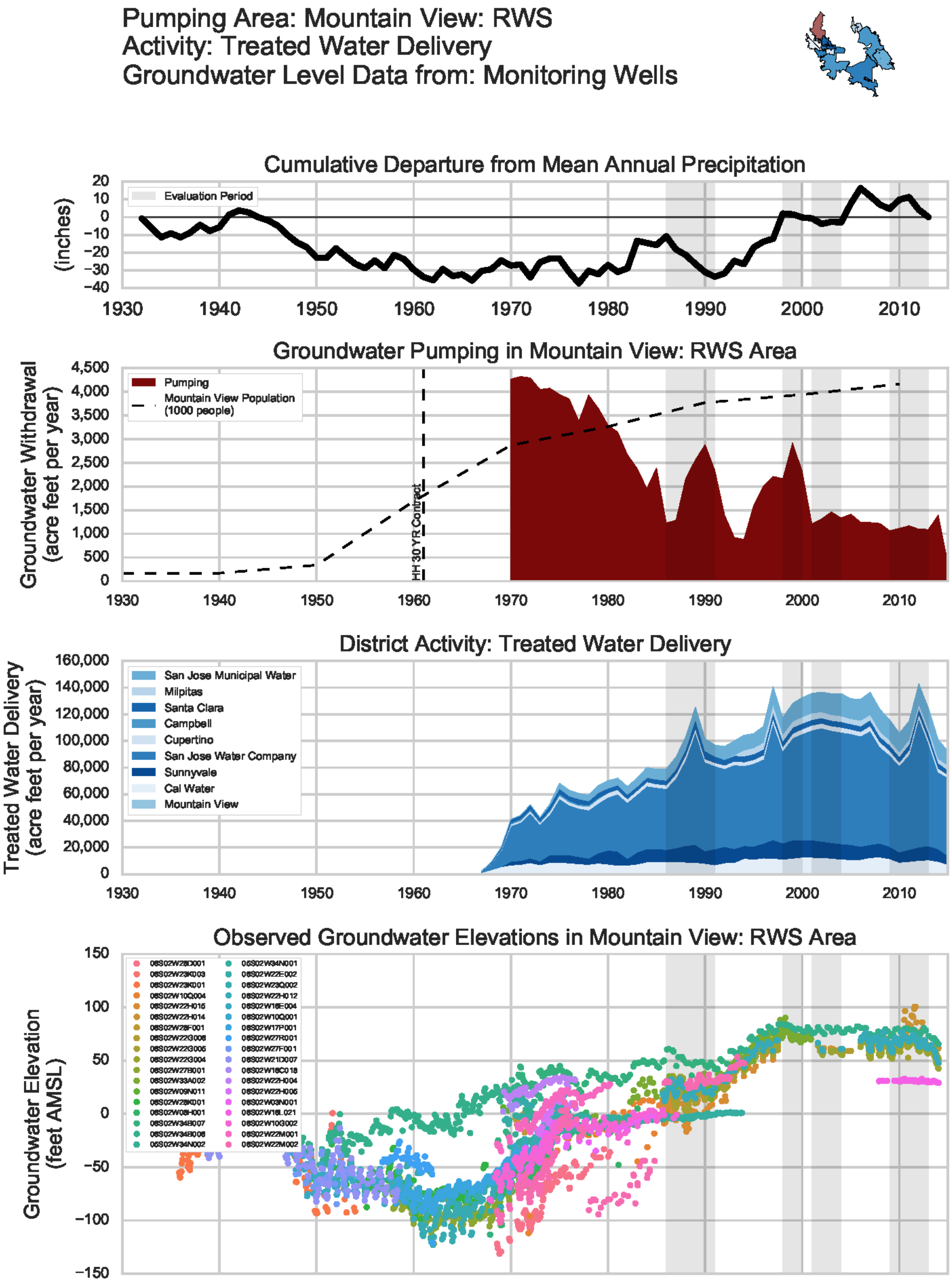


Figure 30. Example of Monitoring Well Groundwater Level Trend Evaluation
of Treated Water in the Santa Clara Subbasin

Pumping Area: Morgan Hill: GW
Activity: Llagas Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

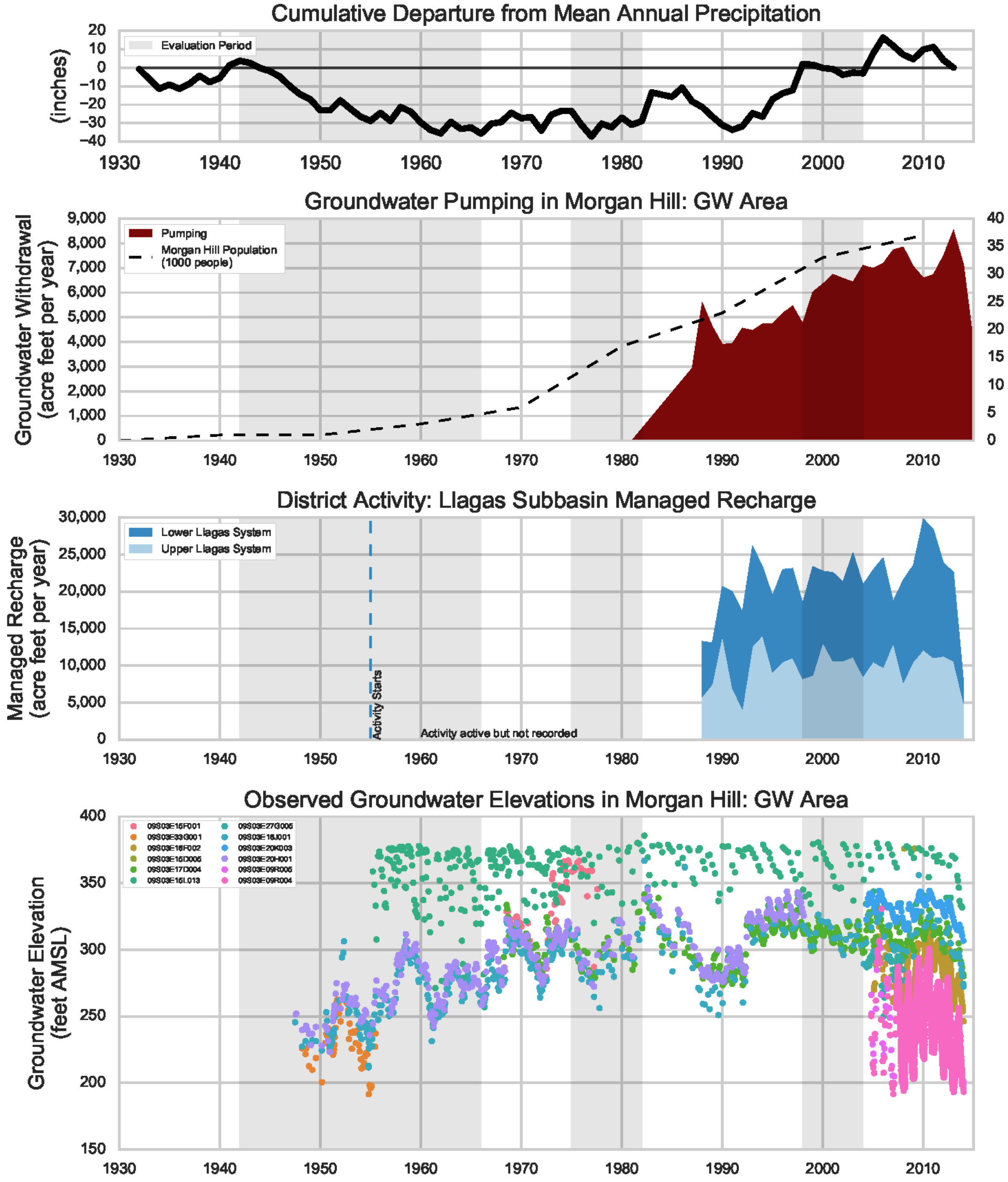
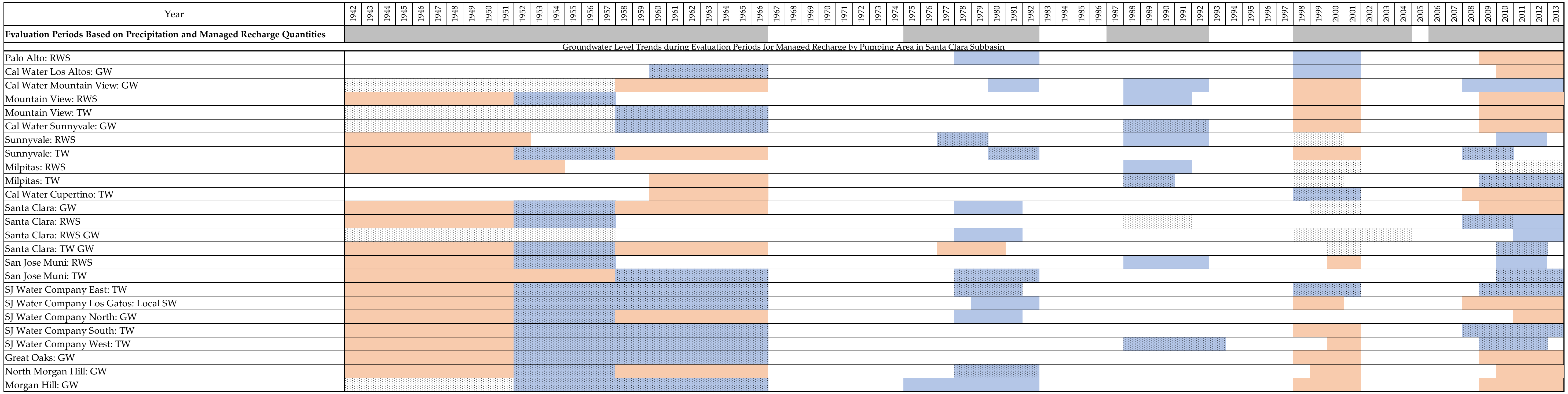


Figure 31. Example of Monitoring Well Groundwater Level Trend Evaluation for Managed Recharge in the Llagas Subbasin

Table 4. Summary of Monitoring Well Groundwater Level Trends during Evaluation Periods for Managed Recharge by Pumping Area in Santa Clara Subbasin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Evaluation Periods Based on Precipitation and Managed Recharge Quantities
Groundwater Level Trends during Evaluation Periods for Managed Recharge by Pumping Area in Santa Clara Subbasin
Palo Alto: RWS
Cal Water Los Altos: GW
Cal Water Mountain View: GW
Mountain View: RWS
Mountain View: TW
Cal Water Sunnyvale: GW
Sunnyvale: RWS
Sunnyvale: TW
Milpitas: RWS
Milpitas: TW
Cal Water Cupertino: TW
Santa Clara: GW
Santa Clara: RWS
Santa Clara: RWS GW
Santa Clara: TW GW
San Jose Muni: RWS
San Jose Muni: TW
SJ Water Company East: TW
SJ Water Company Los Gatos: Local SW
SJ Water Company North: GW
SJ Water Company South: TW
SJ Water Company West: TW
Great Oaks: GW
North Morgan Hill: GW
Morgan Hill: GW

🟧 Decreasing
🟦 Stable/Increasing but Overlapping Activities
▨ Stable/Increasing Not Overlapping - Benefit Demonstrated
▨ Increasing Attributable to Overlapping Activity -Benefit Demonstrated
░ Insufficient Data - Lacking Groundwater Level Data
Not Evaluated Based on Pumping, Precipitation and Managed Recharge Quantities

TW= Retailer supplied by District treated water
RWS= Retailer supplied by SFPUC Regional Water System
Local SW= Retailer supplied by retailer surface water right
GW=Retailer supplied by groundwater
Cal Water: Los Altos TW and San Jose Muni: GW do not have data available during evaluation periods
Stanford: GW, Purissima Hills: GW, SJ Water Company Saratoga: Local SW, Open Space: GW do not have available data

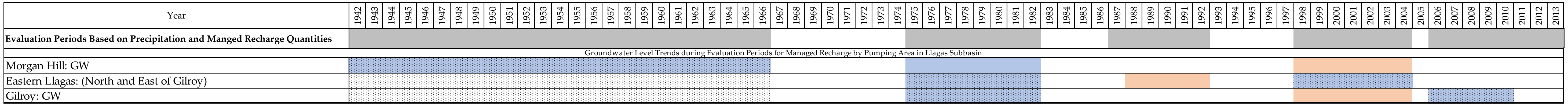
Table 5. Summary of Monitoring Well Groundwater Level Trends during Evaluation Periods for Treated Water by Pumping Area in Santa Clara Subbasin

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Evaluation Periods Based on Precipitation or Treated Water Quantities	▒	▒	▒	▒	▒	▒	▒	▒				▒	▒	▒	▒	▒	▒	▒						▒	▒	▒	▒	▒	▒	▒		▒	▒	▒	▒	▒	▒	▒	▒
Groundwater Level Trends during Evaluation Periods for Treated Water Delivery by Pumping Area in Santa Clara Subbasin																																							
Palo Alto: RWS	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				🟧	🟧	🟧	🟧	🟧	🟧	🟧						🟦	🟦	🟦	🟦	🟦	🟦						🟧	🟧	🟧	🟧	🟧
Cal Water Los Altos: GW												▦	▦	▦										🟦	🟦	🟦	🟦	🟦	🟦	🟦						🟧	🟧	🟧	🟧
Cal Water Mountain View: GW						🟦	🟦	🟦				▨	▨	▨	▨	▨	▨	▨						🟧	🟧	🟧	🟧	🟧	🟧	🟧						🟦	🟦	🟦	🟦
Mountain View: RWS												🟦	🟦	🟦	🟦	🟦	🟦							🟧	🟧	🟧	▦	▦	▦	▦					🟧	🟧	🟧	🟧	🟧
Cal Water Sunnyvale: GW																								🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟦	🟦	🟦	🟦	🟦
Sunnyvale: RWS													▨	▨	▨	▨	▨	▨						░	░	░										▨	▨	▨	
Milpitas: RWS	▦	▦	▦	▦	▦	▦	▦	▦				🟦	🟦	🟦	🟦	🟦	🟦							░	░	░	░	░	░	░						░	░	░	░
Santa Clara: GW	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																	░	░	░								░	░	░	░	░
Santa Clara: RWS GW	🟦	🟦	🟦	🟦	🟦	🟦	🟦																	░	░	░	░	░	░	░							🟦	🟦	🟦
San Jose Muni: RWS												▨	▨	▨	▨	▨	▨	▨								░	░	░	░							▨	▨	▨	
SJ Water Company Los Gatos: Local SW					🟦	🟦	🟦	🟦																🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧	🟧
SJ Water Company North: GW	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																													🟧	🟧	🟧
Great Oaks: GW	▦	▦	▦	▦	▦	▦	▦	▦																🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧	🟧
Morgan Hill: GW	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				🟧	🟧	🟧	🟧	🟧	🟧	🟧						🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧	🟧
North Morgan Hill: GW												🟧	🟧	🟧	🟧	🟧	🟧	🟧							🟧	🟧	🟧	🟧	🟧	🟧						🟧	🟧	🟧	🟧

🟧	**Decreasing**
🟦	**Stable/Increasing but Overlapping Activities**
▦	**Stable/Increasing Not Overlapping - Benefit Demonstrated**
▨	**Increasing Attributable to Overlapping Activity -Benefit Demonstrated**
░	**Insufficient Data - Lacking Groundwater Level Data**
	Not Evaluated Based on Pumping, Precipitation and Managed Recharge Quantities

TW= Retailer supplied by District treated water
RWS= Retailer supplied by SFPUC Regional Water System
Local SW= Retailer supplied by retailer surface water right
GW=Retailer supplied by groundwater
Italicized periods overlap with evaluation periods for managed recharge
Santa Clara: RWS does not have data available during evaluation periods
Stanford: GW, Purissima Hills: GW, SJ Water Company Saratoga: Local SW, Open Space: GW do not have available data

Table 6. Summary of Monitoring Well Groundwater Level Trends during Evaluation Periods for Managed Recharge by Pumping Area in Llagas Subbasin



Year	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Evaluation Periods Based on Precipitation and Manged Recharge Quantities	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒									▒	▒	▒	▒	▒	▒	▒	▒					▒	▒	▒	▒	▒	▒						▒	▒	▒	▒	▒	▒	▒		▒	▒	▒	▒	▒	▒	▒	▒
Groundwater Level Trends during Evaluation Periods for Managed Recharge by Pumping Area in Llagas Subbasin																																																																								
Morgan Hill: GW	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦									🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																🟧	🟧	🟧	🟧	🟧	🟧	🟧									
Eastern Llagas: (North and East of Gilroy)	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░									▦	▦	▦	▦	▦	▦	▦	▦						🟧	🟧	🟧	🟧	🟧						▦	▦	▦	▦	▦	▦	▦									
Gilroy: GW	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░									▦	▦	▦	▦	▦	▦	▦	▦																🟧	🟧	🟧	🟧	🟧	🟧	🟧		▦	▦	▦	▦	▦			

🟧	**Decreasing**
🟦	**Stable/Increasing but Overlapping Activities**
▦	**Stable/Increasing Not Overlapping - Benefit Demonstrated**
▨	**Increasing Attributable to Overlapping Activity -Benefit Demonstrated**
░	**Insufficient Data - Lacking Groundwater Level Data**
	Not Evaluated Based on Pumping, Precipitation and Managed Recharge Quantities

GW=Retailer supplied by groundwater

Italicized periods overlap with evaluation periods for treated water in the Santa Clara Subbasin

Uvas-Chesbro does not have available data

8.2.2 Pumping Well Groundwater Level Trends for Selected Areas

The Study evaluates monitoring wells that do not have associated pumping data because pumping at the individual well can mask any groundwater trends in the area. However, there are a few areas where monitoring wells with data during evaluated periods do not fully cover the area. These areas are Palo Alto, Stanford, Milpitas, the Los Gatos area of San Jose Water Company receiving the company's surface water, the Edenvale area of City of San Jose Municipal receiving only groundwater and the part of the Eastern Llagas area south of Gilroy. In these areas, Appendix F includes plots of groundwater levels from wells with associated pumping data during evaluation periods. Example figures from Appendix F are shown in Figure 32 for managed recharge in the Santa Clara Subbasin.

8.2.3 Areas Where Benefits are Not Demonstrated by Groundwater Level Trends

For the evaluation of benefits from treated water deliveries in the north Morgan Hill non-retailer area between San Jose and Morgan Hill in Coyote Valley, three monitoring wells with data during three evaluation periods show decreasing trends. This may indicate that benefits do not extend from the District deliveries of treated water north of Coyote Narrows into Coyote Valley.

Pumping Area: Palo Alto: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells

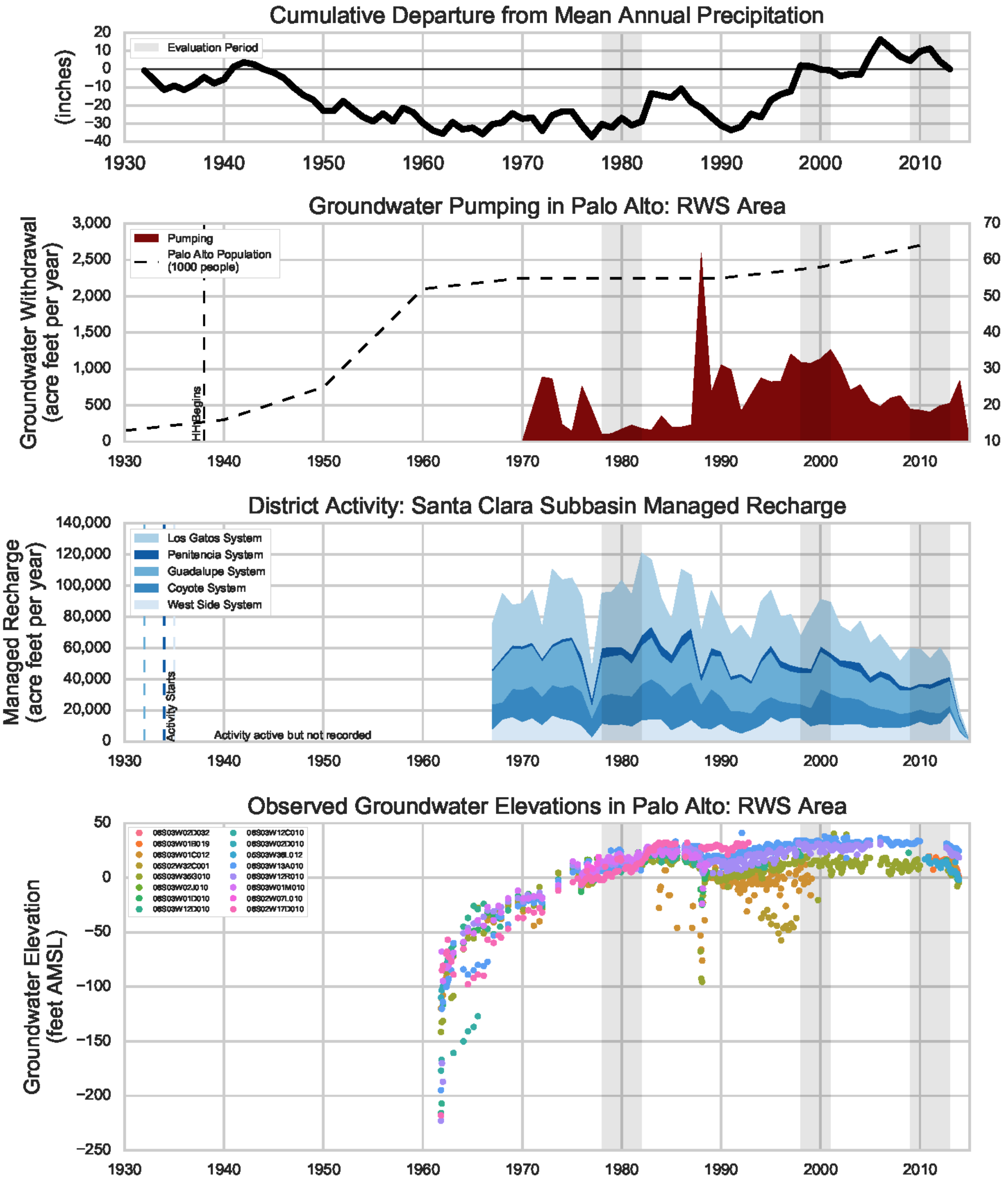


Figure 32. Example of Pumping Well Groundwater Level Trend Evaluation of Managed Recharge in the Santa Clara Subbasin

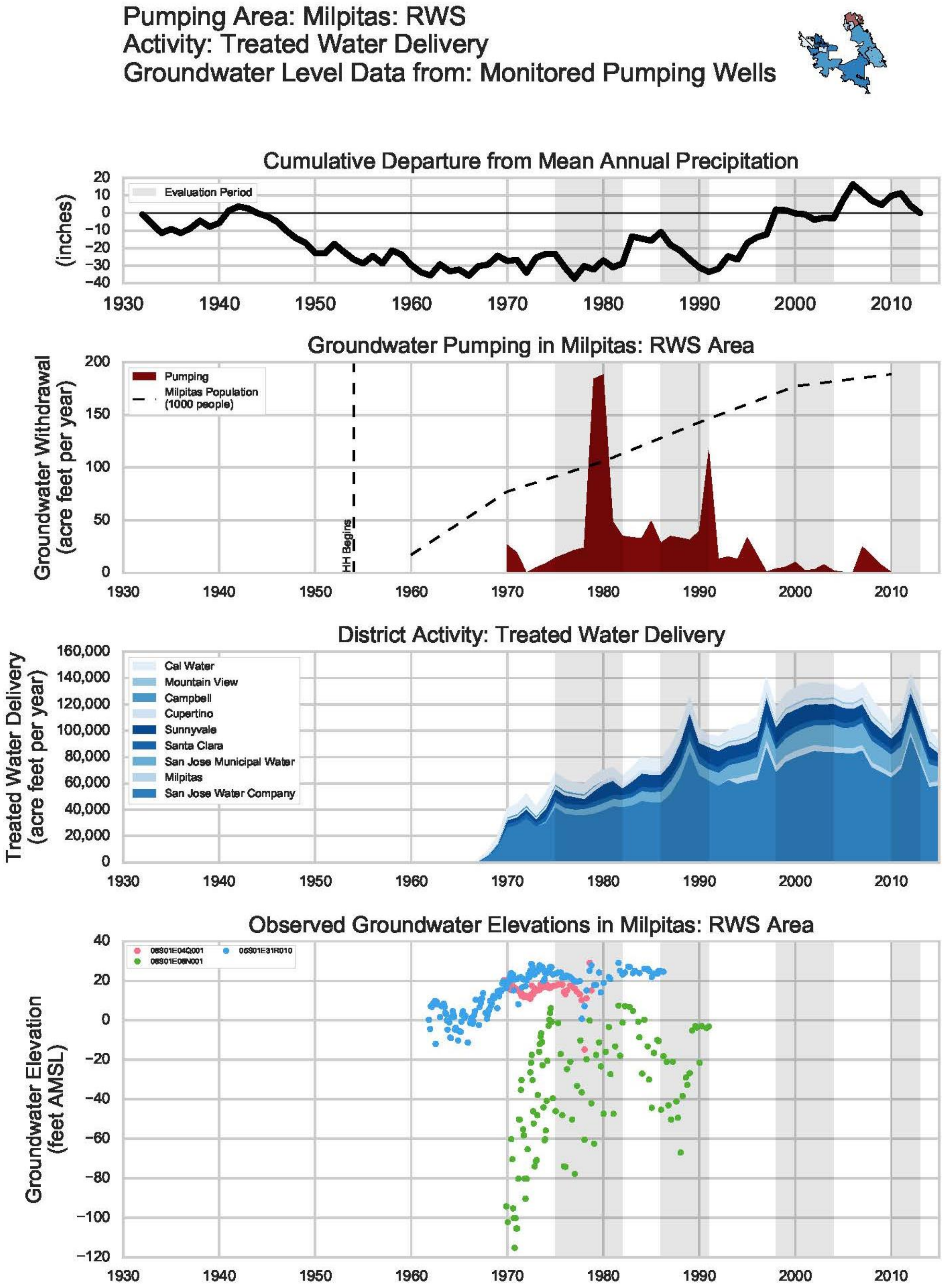
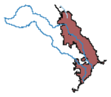


Figure 33. Example of Pumping Well Groundwater Level Trend Evaluation of Treated Water in the Santa Clara Subbasin

Pumping Area: Eastern Llagas:
Activity: Llagas Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells



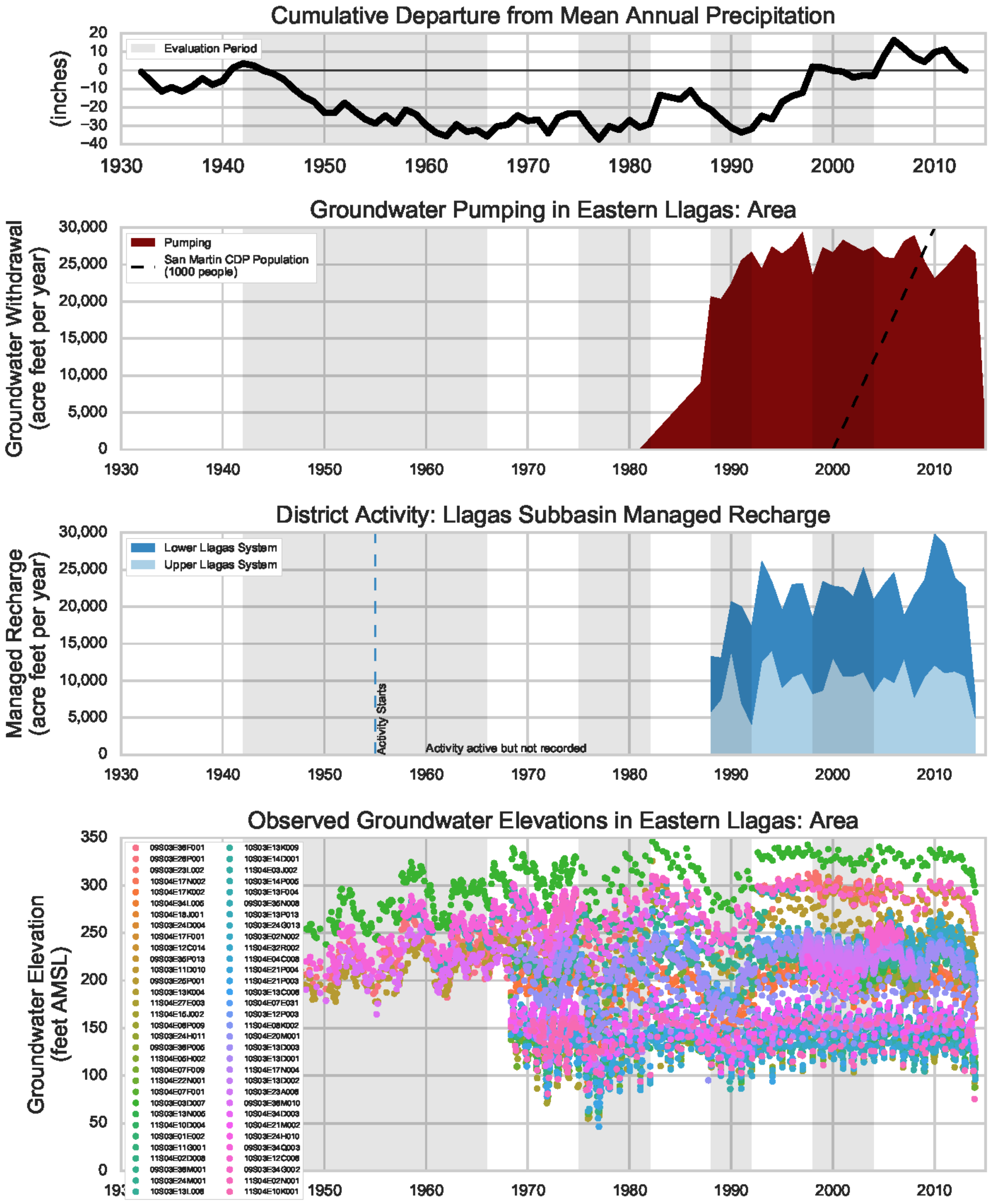


Figure 34. Example of Pumping Well Groundwater Level Trend Evaluation of Managed Recharge in the Llagas Subbasin

Table 7. Summary of Pumping Well Groundwater Level Trends for Selected Pumping Areas

Year	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Evaluation Periods Based on Precipitation and District Activity Quantities	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒										▒	▒	▒	▒	▒	▒	▒	▒					▒	▒	▒	▒	▒	▒						▒	▒	▒	▒	▒	▒	▒		▒	▒	▒	▒	▒	▒	▒	▒
Groundwater Level Trends during Evaluation Periods for Managed Recharge by Pumping Area in Santa Clara Subbasin																																																																								
Stanford: RWS																																					🟦	🟦	🟦	🟦	🟦																░	░	░	░	░									🟧	🟧	🟧
Palo Alto: RWS																																					🟦	🟦	🟦	🟦	🟦																🟦	🟦	🟦	🟦	🟦							🟧	🟧	🟧	🟧	🟧
Milpitas: TW	░	░	░	░	░	░	░	░	░	░	░	░	░						🟧	🟧	🟧	🟧	🟧	🟧	🟧																						▦	▦	▦								░	░	░										░	░	░	░
San Jose Muni: GW	▦	▦	▦	▦	▦	▦	▦	▦	▦	🟧	🟧	🟧	🟧	🟧	🟧	🟧	▦	▦	▦	▦	▦	▦	▦	▦	▦											🟦	🟦	🟦	🟦	🟦	🟦						🟧	🟧	🟧	🟧	🟧						🟦	🟦														
SJ Water Company Los Gatos: Local SW	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦												🟦	🟦	🟦	🟦																	🟧	🟧	🟧								🟧	🟧	🟧	🟧	🟧	🟧
Groundwater Level Trends during Evaluation Periods for Treated Water Delivery by Pumping Area in Santa Clara Subbasin																																																																								
Stanford: RWS																																					🟦	🟦	🟦	🟦	🟦																			▦	▦	▦	▦							🟧	🟧	🟧
Palo Alto: RWS																																		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				🟧	🟧	🟧	🟧	🟧	🟧							🟦	🟦	🟦	🟦	🟦							🟧	🟧	🟧	🟧	🟧
Milpitas: RWS																																		▦	▦	▦	▦	▦	▦	▦	▦				▦	▦	▦	▦	▦	▦							░	░	░	░	░	░	░						░	░	░	░
San Jose Muni: GW																																		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				🟧	🟧	🟧	🟧	🟧	🟧	🟧						🟧	🟧														
SJ Water Company Los Gatos: Local SW																																						🟦	🟦	🟦	🟦																🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧	🟧
Groundwater Level Trends during Evaluation Periods for Managed Recharge by Pumping Area in Llagas Subbasin																																																																									
Eastern Llagas: (South of Gilroy)	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦									▦	▦	▦	▦	▦	▦								🟧	🟧	🟧	🟧	🟧						🟧	🟧	🟧	🟧	🟧	🟧	🟧									

🟧	**Decreasing**
🟦	**Stable/Increasing but Overlapping Activities**
▦	**Stable/Increasing Not Overlapping - Benefit Demonstrated**
▩	**Increasing Attributable to Overlapping Activity -Benefit Demonstrated**
░	**Insufficient Data - Lacking Groundwater Level Data**
	Not Evaluated Based on Pumping, Precipitation and District Activity Quantities

8.2.4 Areas Where Benefits from Are Only Demonstrated by Groundwater Level Trends during Overlapping Periods

There are several areas where groundwater level trends indicate a benefit from either managed recharge, treated water deliveries or both. These areas have stable or increasing groundwater level trends during evaluation periods that overlap in the evaluation of both managed recharge and treated water deliveries. For at least one of the activities, there is no stable or increasing groundwater level trend for a period that is not overlapping so benefit cannot be attributed specifically to the activity unless specific conditions are met. For example, the City of Santa Clara area that only receives groundwater has an increasing groundwater level trend from 1978-1981, which is a period evaluated for both managed recharge and treated water deliveries. A stable groundwater level trend is observed for 1952-1957 so benefit is demonstrated from managed aquifer recharge for periods other than the overlapping period (Figure 35). However, no evaluation periods besides the overlapping period have enough data to evaluate treated water delivery benefits (Figure 36). Therefore, the benefit cannot be attributed specifically to treated water deliveries based on the groundwater level trends for this area. Table 8 shows the areas where groundwater level trends show benefit from District activities during overlapping periods but benefits cannot be distinguished as resulting specifically from one or both of the activities.

A benefit can be specifically attributed to an activity where benefits are demonstrated only during overlapping periods if the activity is increasing while the other activity is stable and groundwater level trends are increasing. This occurs in the areas of Cal Water Mountain View where groundwater is delivered and Sunnyvale and San Jose Municipal Alviso area where Regional Water System water is delivered. For the 1987-1992 and 2010-2012 periods, treated water deliveries increased (Figure 37) while managed aquifer recharge quantities were stable (Figure 38). Meanwhile, groundwater level trends increase in at least one of the two periods for the three areas. Therefore, the benefit can be attributed specifically to treated water deliveries is demonstrated for these three areas. Table 8 also shows the areas where groundwater level trends show benefit from District activities during overlapping periods and benefits specific to the activities are demonstrated.

Pumping Area: Santa Clara: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

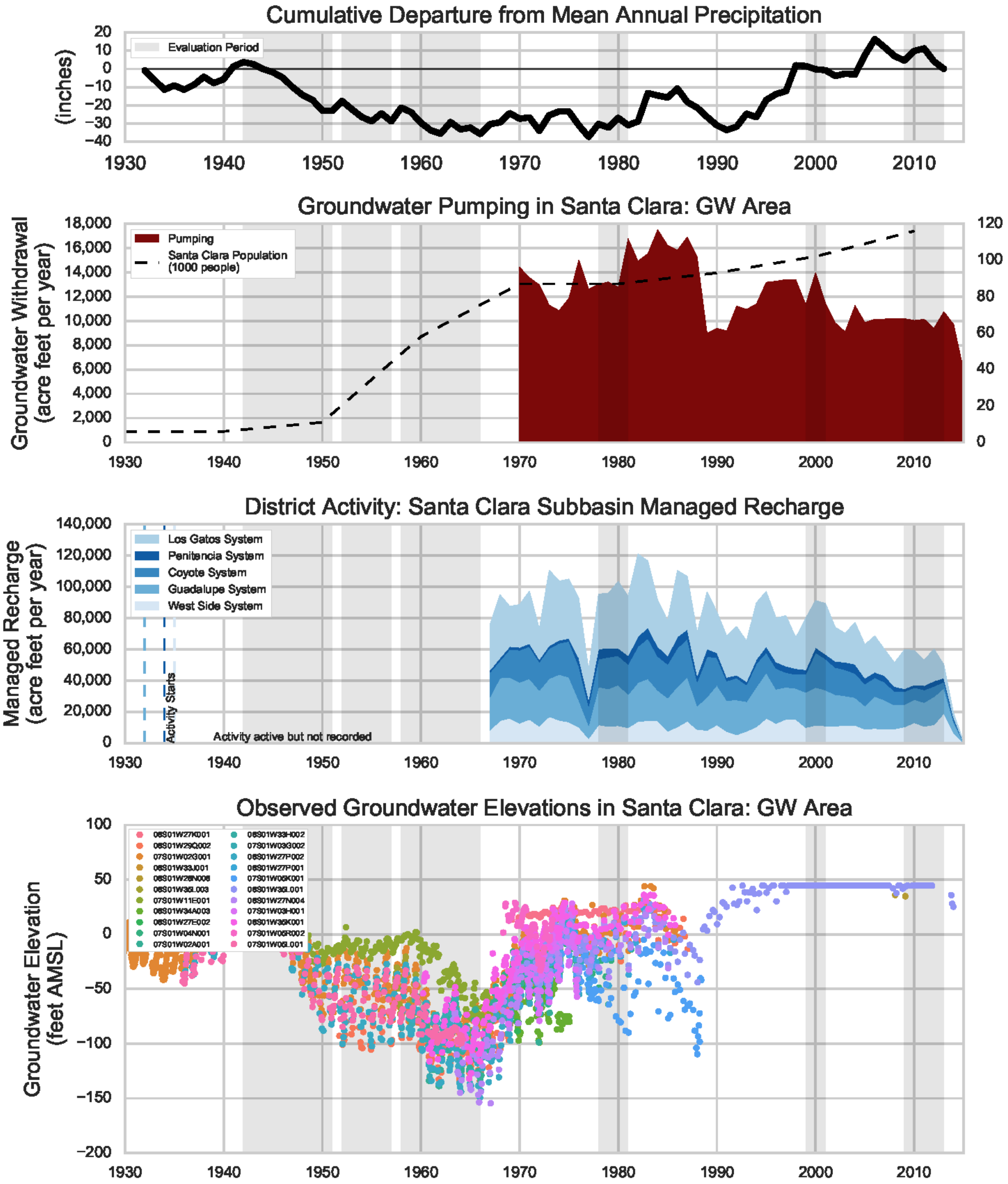


Figure 35. Example of Monitoring Well Groundwater Level Trends Demonstrating Benefits from Managed Recharge Overlapping with a Period Demonstrating Benefits from Treated Water

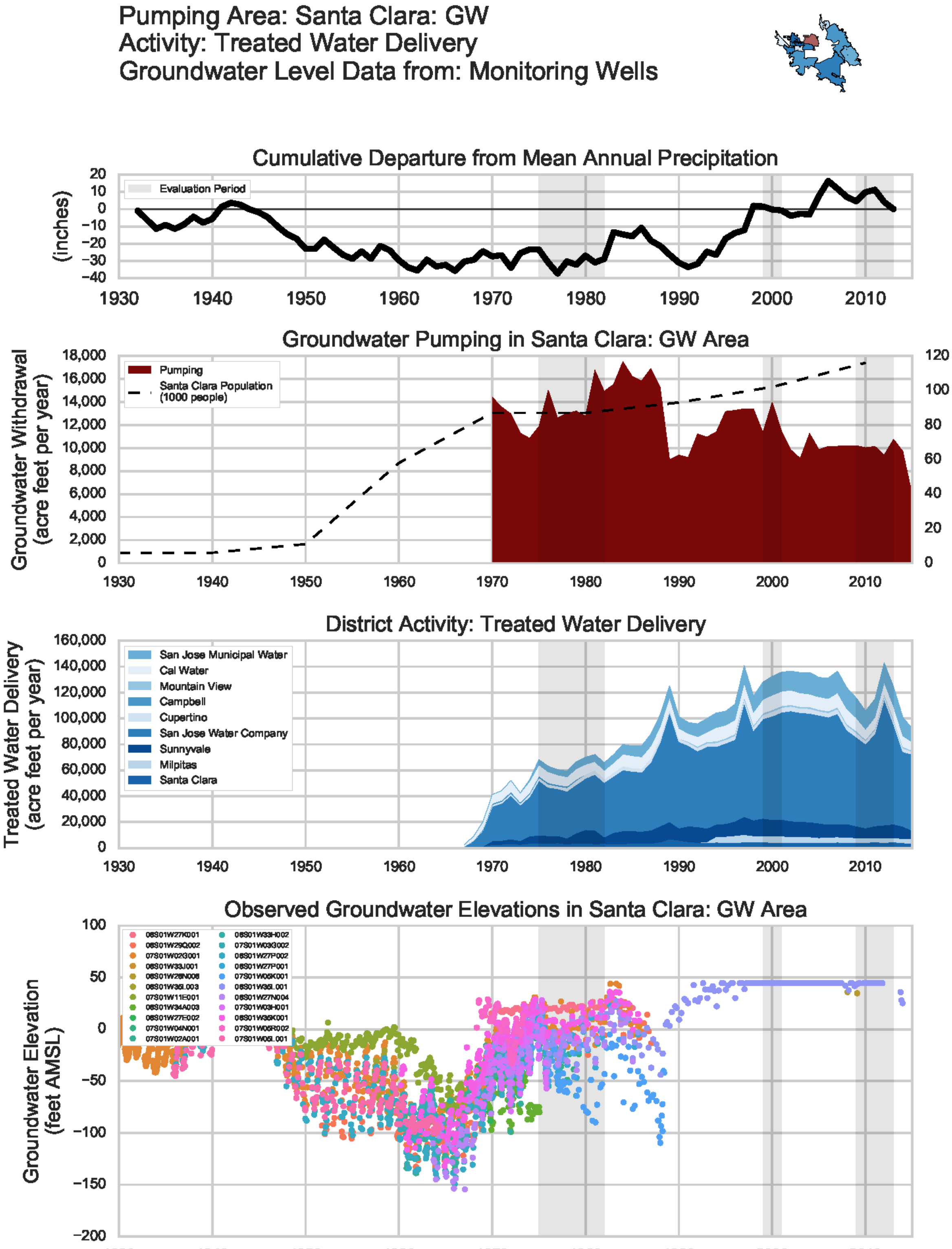
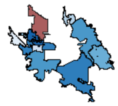


Figure 36. Example of Monitoring Well Groundwater Level Trends Demonstrating Benefits from Treated Water Only in an Overlapping Period

Pumping Area: Sunnyvale: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



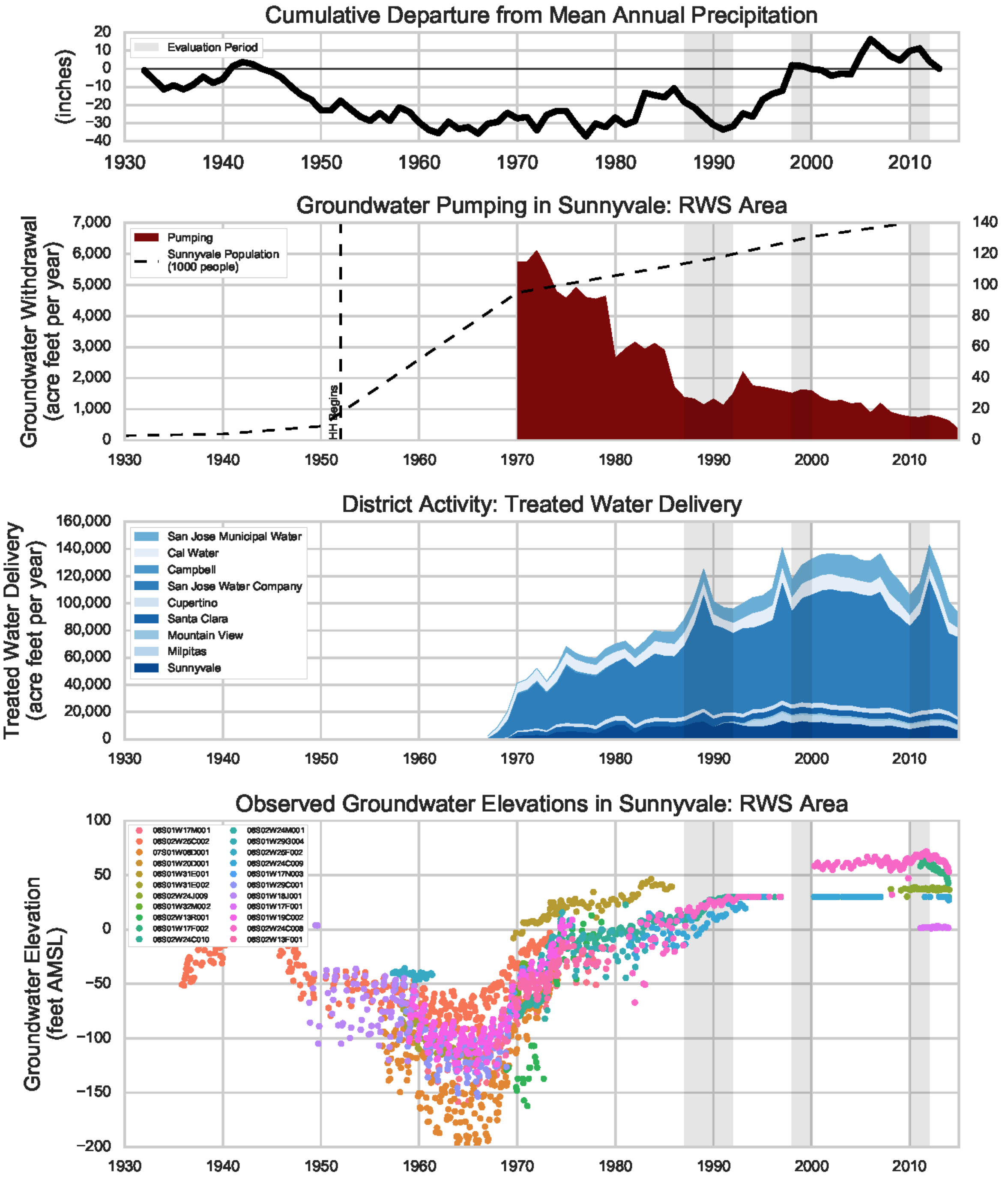


Figure 37. Example of Monitoring Well Groundwater Level Trends Demonstrating Benefits from Treated Water with Increasing Treated Water Deliveries during Overlapping Periods

Pumping Area: Sunnyvale: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

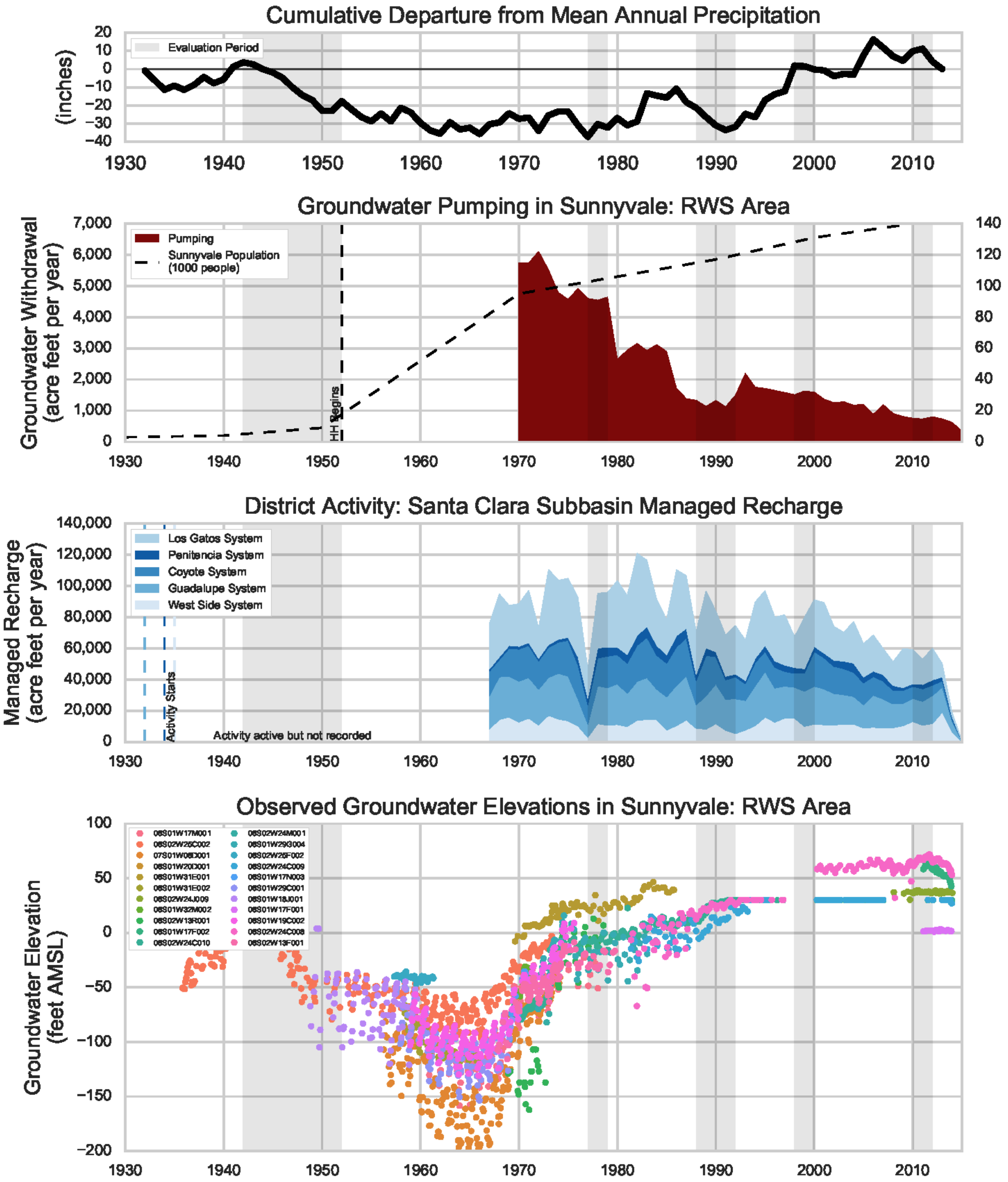


Figure 38. Example of Monitoring Well Groundwater Level Trends Demonstrating Benefits from Managed Recharge with Overlapping Periods of Stable Managed Recharge

Table 8. Pumping Areas and District Activities where Groundwater Level Trends Are Stable or Increasing Only During Evaluation Periods Overlapping with Different District Activity

Year	Pre-1975	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Evaluation Periods Based on Precipitation and District Activity Quantities		■	■	■	■	■	■	■	■					■	■	■	■	■	■						■	■	■	■	■	■	■		■	■	■	■	■	■	■	■
Groundwater Level Trends during Evaluation Periods by Pumping Area in Santa Clara Subbasin																																								
Milpitas: RWS for Treated Water Delivery		▦	▦	▦	▦	▦	▦	▦	▦						🟦	🟦	🟦	🟦																						
Milpitas: RWS for Managed Recharge															🟦	🟦	🟦	🟦																						
Palo Alto: RWS for Treated Water Delivery		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				🟧	🟧	🟧	🟧	🟧	🟧	🟧						🟦	🟦	🟦	🟦	🟦							🟧	🟧	🟧	🟧	🟧
Palo Alto: RWS for Managed Recharge				🟦	🟦	🟦	🟦	🟦																🟦	🟦	🟦	🟦								🟧	🟧	🟧	🟧	🟧	🟧
Stanford: RWS for Treated Water Delivery					🟦	🟦	🟦	🟦	🟦																			▦	▦	▦	▦							🟧	🟧	🟧
Stanford: RWS for Managed Recharge					🟦	🟦	🟦	🟦	🟦																													🟧	🟧	🟧
Cal Water Mountain View: GW for Treated Water Delivery							🟦	🟦	🟦				▨	▨	▨	▨	▨	▨	▨						🟧	🟧	🟧	🟧	🟧	🟧	🟧						🟦	🟦	🟦	🟦
Cal Water Mountain View: GW for Managed Recharge							🟦	🟦	🟦						🟦	🟦	🟦	🟦	🟦						🟧	🟧	🟧	🟧							🟦	🟦	🟦	🟦	🟦	🟦
Santa Clara: RWS GW for Treated Water Delivery		🟦	🟦	🟦	🟦	🟦	🟦	🟦																														🟦	🟦	🟦
Santa Clara: RWS GW for Managed Recharge					🟦	🟦	🟦	🟦																														🟦	🟦	🟦
Cal Water Sunnyvale: GW for Treated Water Delivery																									🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟦	🟦	🟦	🟦	🟦
Cal Water Sunnyvale: GW for Managed Recharge	▦														▦	▦	▦	▦	▦						🟧	🟧	🟧	🟧								🟦	🟦	🟦	🟦	🟦
Sunnyvale: RWS for Treated Water Delivery														▨	▨	▨	▨	▨	▨																		▨	▨	▨	
Sunnyvale: RWS for Managed Recharge				▦	▦	▦									🟦	🟦	🟦	🟦	🟦																		🟦	🟦	🟦	
Santa Clara: GW for Treated Water Delivery		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																															
Santa Clara: GW for Managed Recharge	▦				🟦	🟦	🟦	🟦																												🟧	🟧	🟧	🟧	🟧
San Jose Muni: RWS for Treated Water Delivery													▨	▨	▨	▨	▨	▨	▨																		▨	▨	▨	
San Jose Muni: RWS for Managed Recharge	▦														🟦	🟦	🟦	🟦	🟦								🟧	🟧									🟦	🟦	🟦	
SJ Water Company North: GW for Treated Water Delivery		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																													🟧	🟧	🟧
SJ Water Company North: GW for Managed Recharge	▦														🟦	🟦	🟦	🟦	🟦								🟧	🟧									🟦	🟦	🟦	
SJ Water Company Los Gatos: Local SW for Treated Water Delivery						🟦	🟦	🟦	🟦																🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧	🟧
SJ Water Company Los Gatos: Local SW for Managed Recharge	▦					🟦	🟦	🟦	🟦															🟧	🟧	🟧								🟧	🟧	🟧	🟧	🟧	🟧	🟧
San Jose Muni: GW for Treated Water Delivery						🟦	🟦																																	
San Jose Muni: GW for Managed Recharge	▦					🟦	🟦	🟦	🟦															🟧	🟧	🟧								🟧	🟧	🟧	🟧	🟧	🟧	🟧
Morgan Hill: GW for Treated Water Delivery		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				🟧	🟧	🟧	🟧	🟧	🟧	🟧						🟧	🟧	🟧	🟧	🟧	🟧	🟧					🟧	🟧	🟧	🟧	🟧
Morgan Hill: GW for Managed Recharge	▦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																🟧	🟧	🟧	🟧								🟧	🟧	🟧	🟧	🟧

🟧	**Decreasing**
🟦	**Stable/Increasing (Benefit from District Activities) but Can't Demonstrate Benefit from Specific Activity due to Overlapping Activities in Period**
▦	**Stable/Increasing Not Overlapping - Benefit Demonstrated**
▨	**Increasing Attributable to Overlapping Activity -Benefit Demonstrated**
░	**Insufficient Data - Lacking Groundwater Level Data**
	Not Evaluated Based on Pumping, Precipitation and District Activity Quantities

Several of the areas where benefits to specific activities are not demonstrated, Mountain View, Santa Clara, and San Jose Water Company North, are surrounded by areas that have demonstrated benefits from both managed recharge and treated water deliveries and can reasonably be assumed to also benefit from both activities due to hydrogeologic connection. Figure 39 and Figure 40 show the areas where the groundwater level trend evaluation demonstrates benefits that can be specifically attributed to each of managed aquifer recharge and treated water deliveries in relation to these areas.

The Palo Alto area shows stable groundwater levels for both 1975-1982 and 1998-2002 that are overlapping periods for evaluating benefits from both managed recharge and treated water deliveries in the Santa Clara Plain. There are no other evaluation periods for managed recharge in this area and the two periods for only treated water deliveries showed a decreasing trend. The groundwater level trends show a benefit from District activities in this area but the groundwater level trends for the areas cannot be used to attribute the benefit to the specific activities.

Likewise, the Stanford area shows stable groundwater levels for 1978-1982 that is an overlapping period for evaluating benefits from treated water deliveries and managed aquifer recharge activities and no other evaluation periods with sufficient data to evaluate managed recharge. Data from Stanford wells during the 1998-2004 evaluating period for treated water delivery show an increasing trend. Although the groundwater level trend evaluation for the Stanford area identifies benefits from District activities, it is only able to distinguish that benefits are from the treated water delivery activities and not managed aquifer recharge. The benefits from the District’s managed aquifer recharge are further evaluated by groundwater modeling (Section 9).

The demonstration of benefit specific to treated water deliveries in the Stanford area demonstrate this benefit through the Palo Alto area and the benefits from the District’s managed aquifer recharge are further evaluated by groundwater modeling (Section 9).

The San Jose Water Company area in Los Gatos where the company’s local surface water is delivered shows stable groundwater levels for 1979-1982, that this is an overlapping period for evaluating benefits from both managed recharge and treated water deliveries. Stable or increasing trends occur during other evaluation periods for managed recharge but only decreasing trends occur for other evaluation periods for treated water deliveries. The groundwater level trends show a benefit from managed recharge in this area but the groundwater level trends for the areas cannot be used to attribute a benefit specifically to treated water deliveries.

Monitoring wells in Morgan Hill and production wells in the Coyote service area of San Jose Municipal Water receiving only groundwater both show increasing groundwater level trends only during 1975-1982, overlapping with evaluation of managed recharge. In the evaluation of managed recharge, other periods show groundwater level trends demonstrating benefit. These areas are in the Coyote Valley area where the north Morgan Hill area between San Jose and Morgan Hill does not have groundwater level trends demonstrating benefit from treated water delivery. In addition, the treated water delivery is north of Coyote Narrows where a steep groundwater gradient potentially limits hydrogeologic connection. Therefore, it is more likely that the increasing groundwater level trends occurring during 1975-1982 are a result of managed recharge from Coyote Creek in the Coyote Valley area instead of treated water delivery to the north of Coyote Narrows.

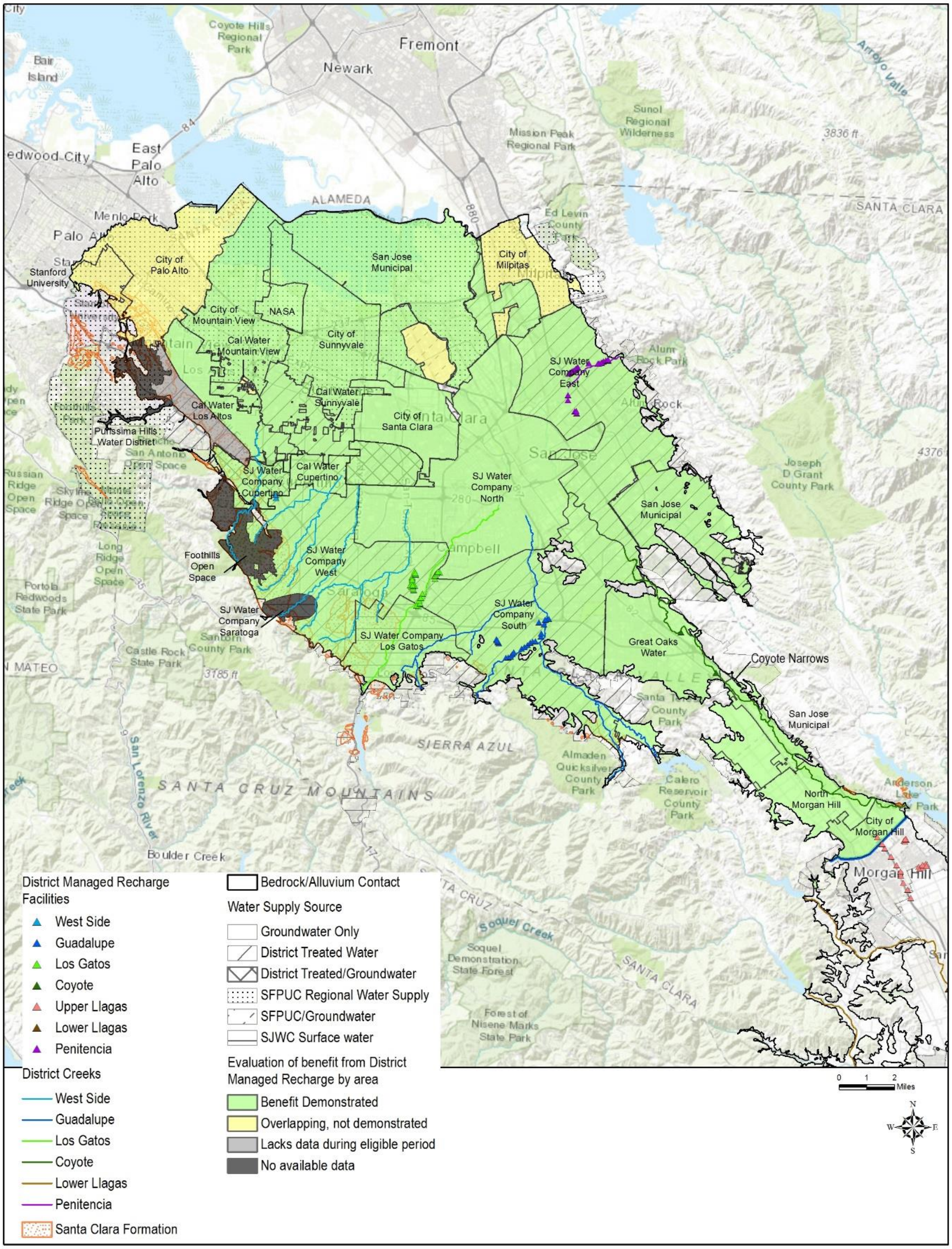


Figure 39. Results of Groundwater Level Trend Evaluation of Benefits from Managed Aquifer Recharge in Santa Clara Subbasin

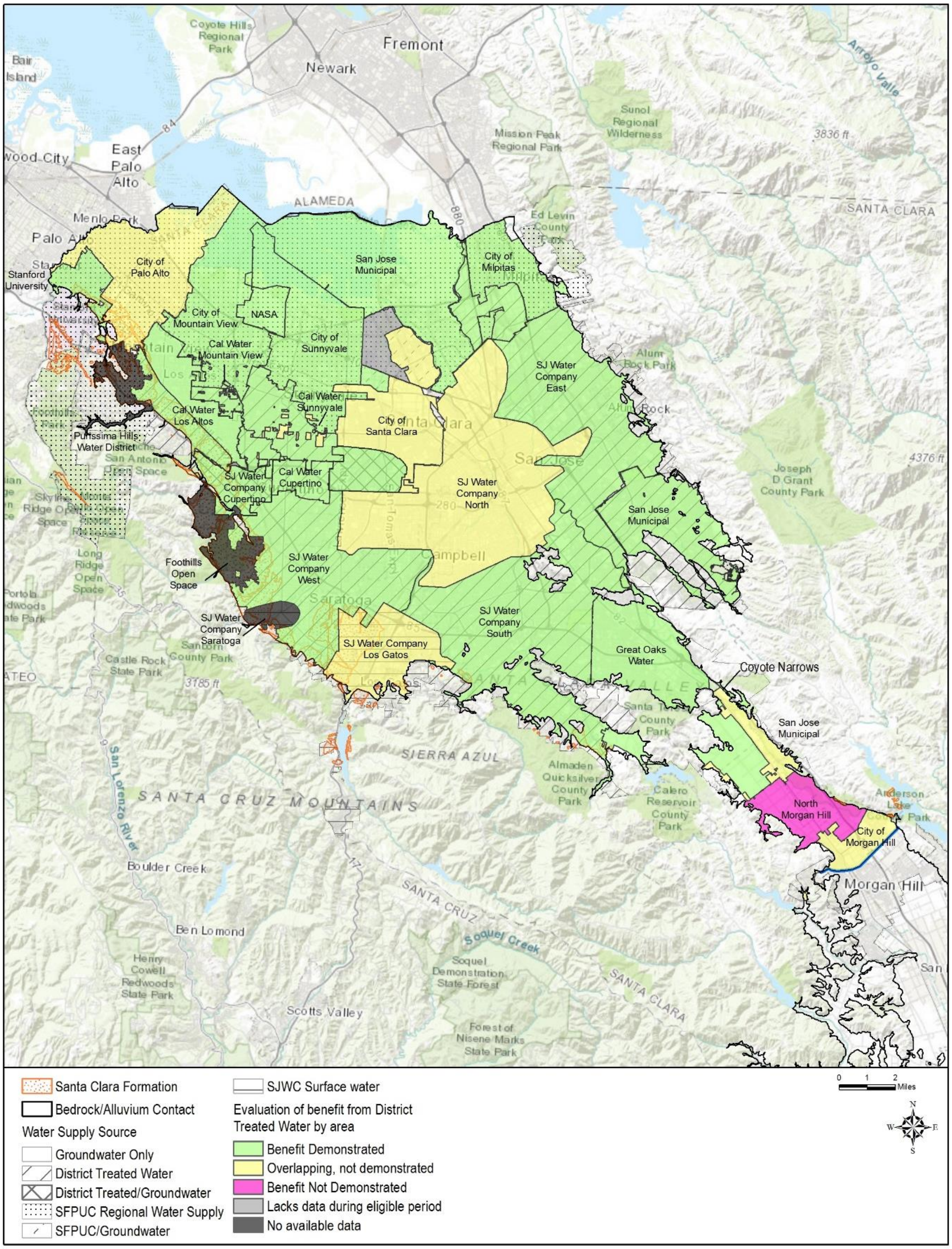


Figure 40. Results of Groundwater Level Trend Evaluation of Benefits from Treated Water Deliveries in Santa Clara Subbasin

8.3 Areas without Groundwater Level Data

8.3.1 Areas Where Groundwater Level Data Unavailable during Evaluation Periods for Activities

There are two areas where groundwater level data are not available during evaluation periods for a District activity. These areas are the Los Altos area served District treated water by Cal Water and the small area of the City of Santa Clara where only SFPUC RWS water is delivered.

In the Cal Water Los Altos area where District treated water is delivered, there are no groundwater level data available for periods used to evaluate benefits from managed recharge (Appendix C). This area overlaps the Santa Clara Formation which may have limited hydrogeologic connection with managed recharge activities in the Unconsolidated Alluvium outside the Santa Clara Formation (Section 5.6).

In the small area of the City of Santa Clara where only SFPUC RWS water is delivered, there are no groundwater level data to evaluate trends during periods used to evaluate benefits from treated water deliveries (Appendix D). However, benefits from District treated water deliveries are demonstrated in hydrogeologically connected surrounding areas: Sunnyvale area where only SFPUC RWS water is delivered and City of San Jose Municipal where only SFPUC RWS water is delivered (Figure 40). Therefore, it is reasonable to assume that this area of the City of Santa Clara, even without local groundwater level data, also benefits from treated water deliveries.

8.3.2 Areas without Available Groundwater Level Data

There are areas where no groundwater level data are available. These areas include Purissima Hills, San Jose Water Company in Saratoga receiving surface water from the company’s own surface water right, the Open Space area and the Uvas-Chesbro area.

Purissima Hills Water District and Open Space area overlaps with bedrock and the Santa Clara Formation, while the surface water delivery area of San Jose Water Company in Saratoga overlap with bedrock, Santa Clara Formation, and Unconsolidated Alluvium. The Santa Clara Formation also has partial overlap with other areas including Palo Alto and San Jose Water Company in Los Gatos. There are no groundwater level data to evaluate in the Santa Clara Formation to evaluate hydrogeologic connection throughout the Santa Clara Formation. Bedrock is not considered to have hydrogeologic connection with District activities in other areas, while available information for the Santa Clara Formation does not support concluding that there is hydrogeologic connection with managed recharge activities in the Unconsolidated Alluvium (Section 5.6).

The Uvas-Chesbro area is west of bedrock outcrops in the Llagas Subbasin (Figure 28) which may limit the hydrogeologic connection with managed recharge of imported water that occurs east of the bedrock outcrops and groundwater level trends demonstrate benefits from managed recharge of imported water.

8.4 Statistical Analysis

In order to quantify the groundwater level trends used to demonstrate improvement, a Mann-Kendall test was performed for data at each well over the time period when a trend for the area of the well demonstrates improvement. The Mann-Kendall test is appropriate because it is non-parametric and does not rely on the distribution of the data set (Heisel and Hirsch, 2002). The Mann-Kendall test statistic tau represents whether there is a trend detected on a scale from -1 to 1, with -1 representing a decreasing trend and 1 representing an increasing trend. The padj statistic represents the level of significance of the tau result on a scale from 0 to 1. Appendix G summarizes the Mann-Kendall statistics results by well grouped by retailer well area.

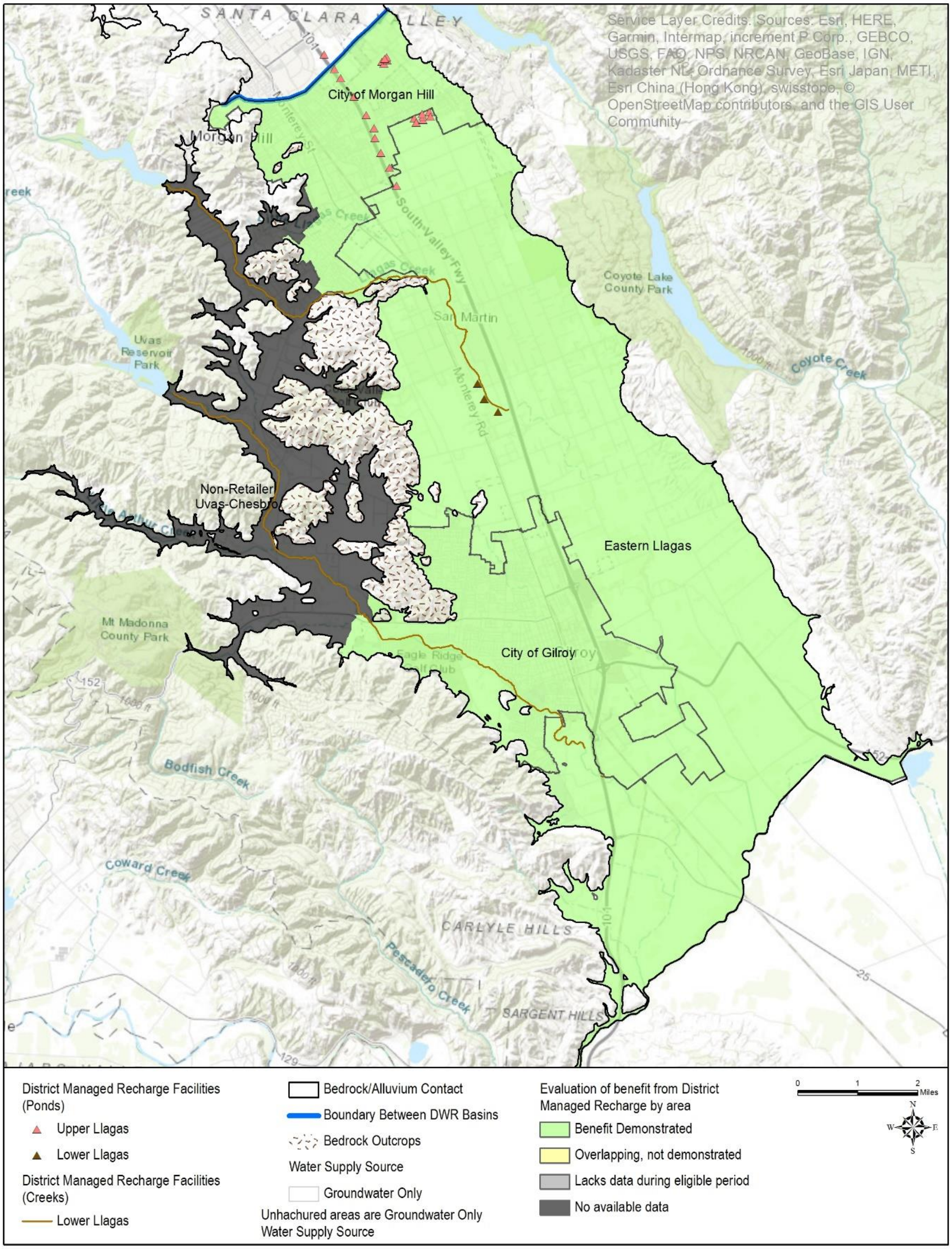

SANTA CLARA VALLEY
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
City of Morgan Hill
Morgan Hill
Monterey St
Llagas Creek
South Valley Fwy
San Martin
Monterey Rd
Coyote Lake County Park
Coyote Creek
Uvas Reservoir Park
Non-Retailer Uvas-Chesbro
Eastern Llagas
Mt Madonna County Park
City of Gilroy
Eagle Ridge Golf Club
152
101
Bodfish Creek
Coward Creek
CARLYLE HILLS
Pescadero Creek
SARGENT HILLS
25
129
District Managed Recharge Facilities (Ponds)
Upper Llagas
Lower Llagas
District Managed Recharge Facilities (Creeks)
Lower Llagas
Bedrock/Alluvium Contact
Boundary Between DWR Basins
Bedrock Outcrops
Water Supply Source
Groundwater Only
Unhachured areas are Groundwater Only Water Supply Source
Evaluation of benefit from District Managed Recharge by area
Benefit Demonstrated
Overlapping, not demonstrated
Lacks data during eligible period
No available data
0
1
2
Miles
N
W
E
S

Figure 41. Results of Groundwater Level Trend Evaluation of Benefits from Managed Aquifer Recharge in Llagas Subbasin

9 GROUNDWATER MODEL SIMULATIONS

9.1 Groundwater Modeling Approach

The District ran simulations with its groundwater flow models for the Santa Clara Plain (CH2M Hill, 1992) and Llagas Subbasin (CH2M Hill, 2005) to evaluate the extent of benefits from District activities. The groundwater flow models have been calibrated to historical data and are therefore appropriate for use to supplement the groundwater level data evaluation in Section 6 in evaluating effects of District activities on groundwater flow. Groundwater modeling facilitates the evaluation of benefits from a specific District activity without confounding effects from other groundwater conditions or activities. This is accomplished by comparing model runs with the District activity to model runs with the District activity removed or reduced. The model run with the District activity is represented by a baseline simulation of historical conditions that includes the District activity. The model run removing or reducing the District activity has the same inputs as the baseline except for the District activity.

Comparing model runs with the only change being the District activity provides a line of evidence supporting groundwater level data evaluation presented in Section 8 especially in areas where data are limited or there are overlapping evaluation periods that prevent assigning benefits to a specific District activity, and where District activities such as managed aquifer recharge of local water and imported water cannot be separated in the data. The model runs can also be used to evaluate benefits from recycled water activities, which has quantities that are too small to evaluate in the groundwater level data evaluation.

Model results depend on modeling assumptions used to create the models, particularly the model domain covered. Therefore, use of the model to demonstrate the extent of benefits needs to be consistent with the groundwater level evaluation described in Section 8.

The District’s Coyote Valley model is not used for this evaluation. This model’s simulation of the recharge from the Coyote Creek managed recharge system is based on stream levels that are not conducive to testing the effects of reduced recharge quantities. The groundwater level trend evaluation demonstrated a benefit from managed recharge in all areas the Coyote Valley so modeling results would only affirm that conclusion. The groundwater level trend evaluation did not demonstrate a benefit from treated water deliveries in the Santa Clara Plain. The model also cannot directly simulate deliveries in the Santa Clara Plain as the model’s northern domain boundary is the Coyote Narrows.

Table 9. Summary of Groundwater Model Simulations Evaluated for Study

Model	Period	Scenario No.	District Activity Evaluated	Model Implementation for District Activity
Santa Clara Plain	1970-2015	1	None (Baseline)	Historical Pumping and Managed Recharge
		2	Treated Water Delivery	Increased Pumping by 50% of Treated Water Deliveries
		5	Managed Aquifer Recharge	Eliminates District Managed Aquifer Recharge
		6	Recycled Water	Increased Pumping in Areas Receiving Recycled Water
Llagas	1987-2015	Baseline	None (Baseline)	Historical Pumping and Managed Recharge
		1	Managed Aquifer Recharge of Local Runoff	Eliminates District Managed Aquifer Recharge of Local Runoff in Upper Llagas and Lower Llagas Systems
		2	Managed Aquifer Recharge of Imported Water	Eliminates District Managed Aquifer Recharge of Imported Water in Upper Llagas System
		4	Recycled Water	Increased Pumping in Areas Receiving Recycled Water

9.2 Santa Clara Plain Model Simulations

The District ran simulations using the Santa Clara Plain groundwater model following the approach outlined above. One of the main assumptions implemented in this model is that the domain covers the Unconsolidated Alluvium but does not cover most of the Santa Clara Formation outcrop area. The initial modeling is documented in the District’s memo (Liu and Zhan, 2016) included as Appendix H. Any necessary revisions to the initial modeling are described below. The Study uses modeling that evaluates treated water deliveries (Scenario 2), managed aquifer recharge (Scenario 5), and recycled water deliveries (Scenario 6) separately. The Study does not use Scenarios 3 and 4 (documented in Appendix F) evaluating effects of recharging only imported water and only local runoff because all managed recharge systems in the Santa Clara Plain are connected to the imported water system and can recharge both imported water and local runoff. All runs simulate historical climatic conditions from 1970-2015.

9.2.1 Baseline

Scenario 1 simulates historical conditions from 1970-2015 for pumping and managed recharge. Results from all other scenarios are compared to this scenario to evaluate the extent of benefit from a specific District activity. This comparison is done by subtracting groundwater level results at the end of each of the other scenarios from the results at the end of this baseline run (Figure 42 through Figure 44). A positive difference in the groundwater levels indicate a benefit from the District activity because the baseline run includes the District activity as fully implemented historically. The Study evaluates each map of the groundwater level difference in 2015 for demonstrated extent of benefits. Yellow represents the minimum groundwater level difference of 0.6 feet across all scenarios when compared to the baseline scenario. Dark blue represents the maximum groundwater level difference of 124 feet across all scenarios when compared to the baseline scenario.

9.2.2 Reduced Treated Water Deliveries

Scenario 2 estimates the effects of reducing treated water deliveries by 50% by assuming that any reduced deliveries would be made up for with increased pumping. The model simulates this by increasing pumping by one half of treated water delivery quantities to simulate the decrease in in-lieu recharge from reduced treated water deliveries. The increases occur at selected wells of retailers that have received treated water deliveries. Treated water deliveries are only partially reduced because increasing pumping by the full amount alters the water budget so significantly that it causes numerical problems for the model. The run described in Appendix G (Liu and Zhan, 2016) that increases pumping from 1970-2015 also encounters numerical problems by the end of 2013 so District staff revised the run to only increase pumping for 2005-2015. Figure 42 shows the groundwater level difference between baseline Scenario 1 and Scenario 2 at the end of 2015. This figure shows that eleven years of treated water deliveries increased groundwater levels throughout the Unconsolidated Alluvium of the Santa Clara Plain, ranging from 1.9 feet to 97 feet.

9.2.3 Reduced Managed Aquifer Recharge

Scenario 5 eliminates all District managed recharge from 2005-2015. Figure 43 shows the groundwater level difference between baseline Scenario 1 and Scenario 5 at the end of 2015. This figure shows that eleven years of managed recharge increased groundwater levels throughout the Unconsolidated Alluvium of the Santa Clara Plain, ranging from 3.9 feet to 124 feet. The increases are distributed differently than increases from treated water (Figure 42) with the highest increases where creeks pass through unconfined areas.

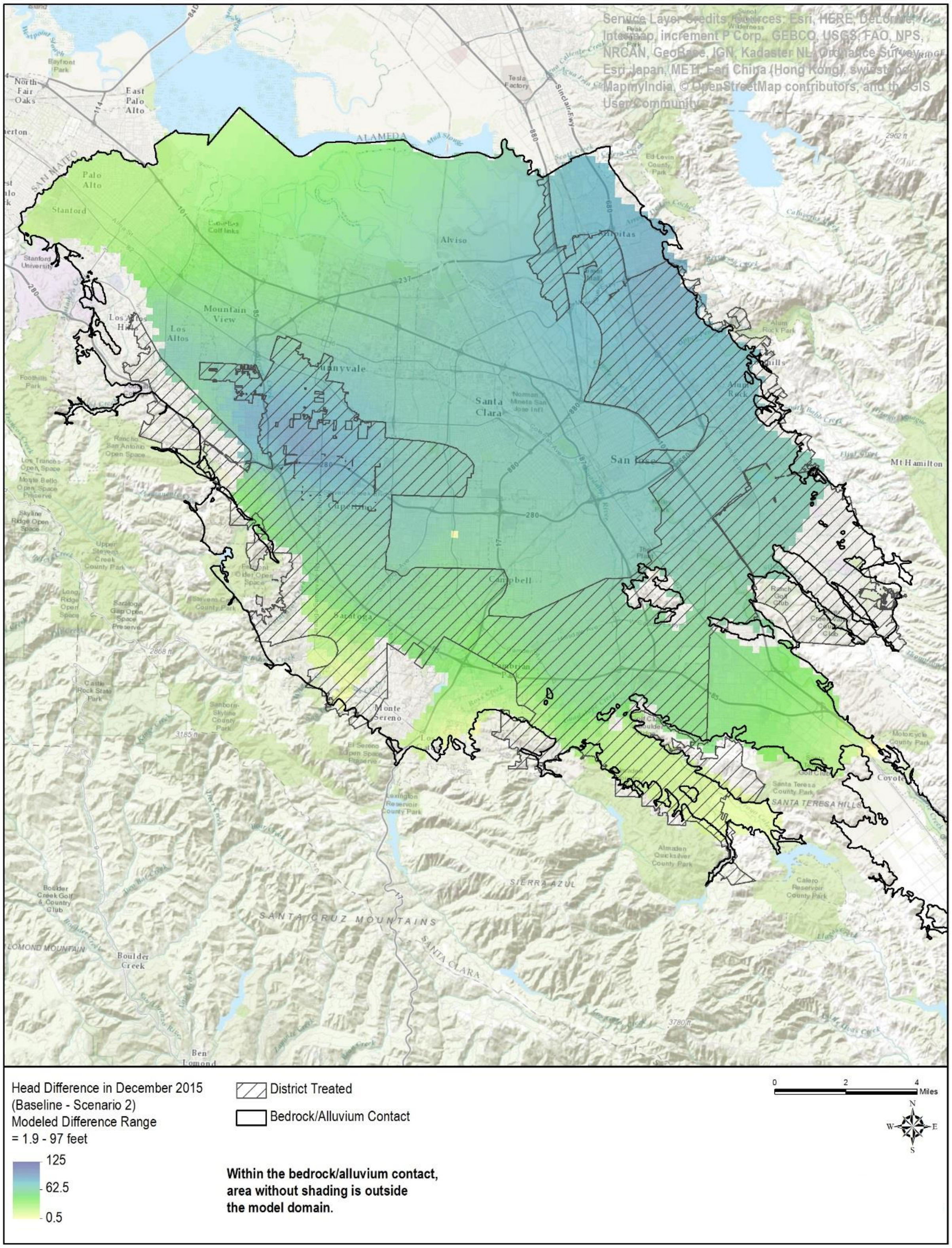

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Palo Alto
Stanford
Alviso
Milpitas
Mountain View
Los Altos
Sunnyvale
Santa Clara
San Jose
Cupertino
Campbell
Saratoga
Monte Sereno
Mt Hamilton
SANTA CRUZ MOUNTAINS
SIERRA AZUL
Head Difference in December 2015
(Baseline - Scenario 2)
Modeled Difference Range
= 1.9 - 97 feet
125
62.5
0.5
District Treated
Bedrock/Alluvium Contact
Within the bedrock/alluvium contact, area without shading is outside the model domain.
0
2
4
Miles
N
S
E
W

Figure 42. Simulated Groundwater Difference due to Reduced Treated Water Deliveries in Santa Clara Plain

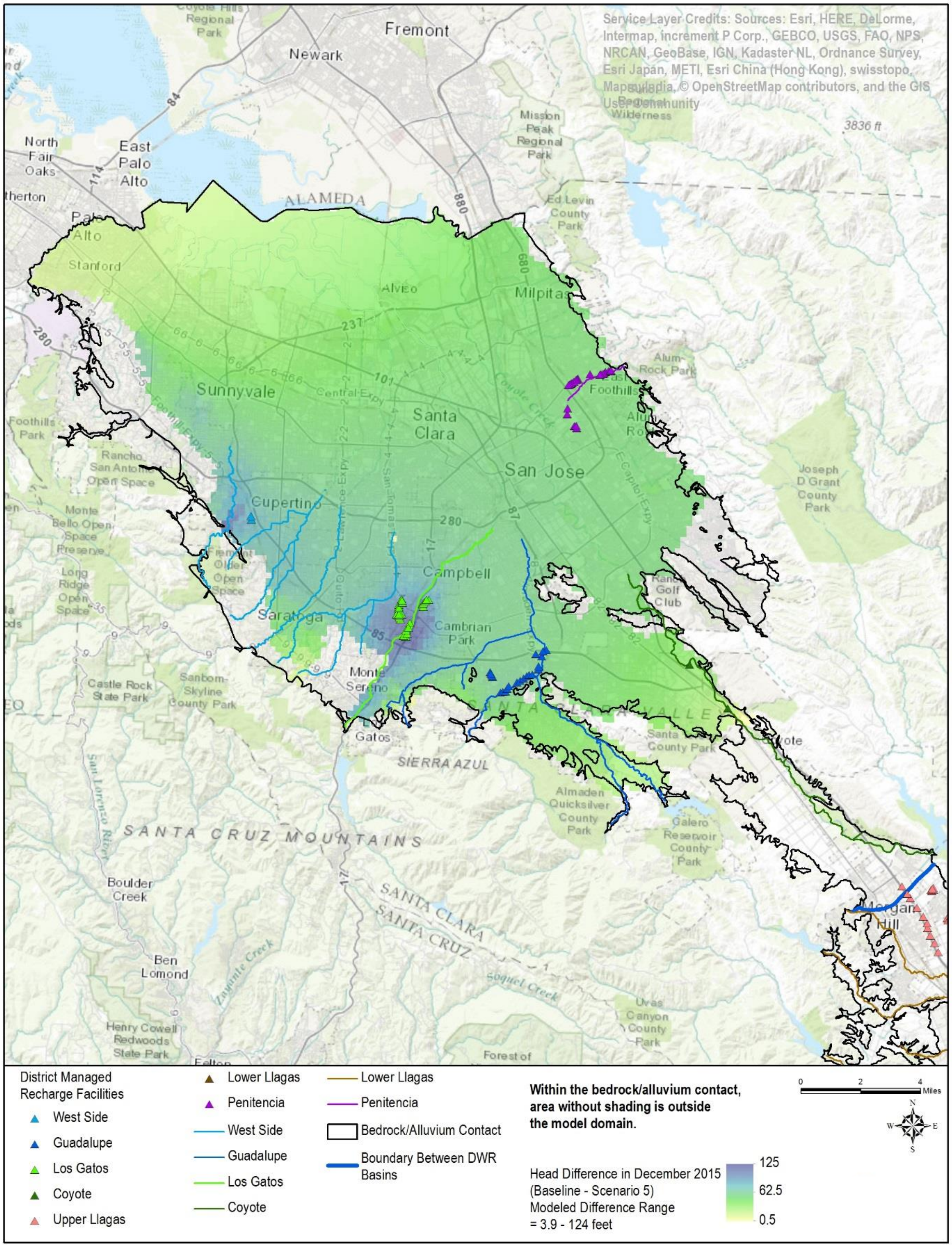

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapmyindia, © OpenStreetMap contributors, and the GIS User Community
Fremont
Newark
East Palo Alto
North Fair Oaks
Palo Alto
Stanford
Alviso
Milpitas
Sunnyvale
Santa Clara
San Jose
Cupertino
Campbell
Saratoga
Cambrian Park
Monte Sereno
Los Gatos
SIERRA AZUL
SANTA CRUZ MOUNTAINS
Morgan Hill
Boulder Creek
Ben Lomond
District Managed Recharge Facilities
West Side
Guadalupe
Los Gatos
Coyote
Upper Llagas
Lower Llagas
Penitencia
West Side
Guadalupe
Los Gatos
Coyote
Lower Llagas
Penitencia
Bedrock/Alluvium Contact
Boundary Between DWR Basins
Within the bedrock/alluvium contact, area without shading is outside the model domain.
Head Difference in December 2015 (Baseline - Scenario 5)
Modeled Difference Range = 3.9 - 124 feet
125
62.5
0.5
0
2
4
Miles
N
E
S
W

Figure 43. Simulated Groundwater Difference due to Reduced Managed Recharge in Santa Clara Plain

9.2.4 Reduced Recycled Water

Scenario 6 simulates reduced recycled water deliveries by assuming a reduction in these deliveries would be made up for with increased pumping. The model simulates this by increasing pumping by the recycled water delivery quantities. Pumping was increased at selected retailer wells in the area of the Palo Alto, Sunnyvale, and South Bay Water Recycling areas. Figure 44 shows the groundwater level difference between the baseline Scenario 1 and Scenario 6 with groundwater level increases due to recycled water deliveries throughout the Unconsolidated Alluvium of the Santa Clara Plain, ranging from 0.6 feet to 41 feet.

The figure shows groundwater level differences throughout the Santa Clara Plain are much smaller than differences for the reduced treated water (Scenario 2) and reduced managed recharge (Scenario 5) due to the smaller volume of recycled water delivered. This confirms that District in-lieu recharge activities such as recycled water and untreated surface water with relatively small deliveries have benefits throughout the Unconsolidated Alluvium but benefits will be difficult to demonstrate with groundwater level data.

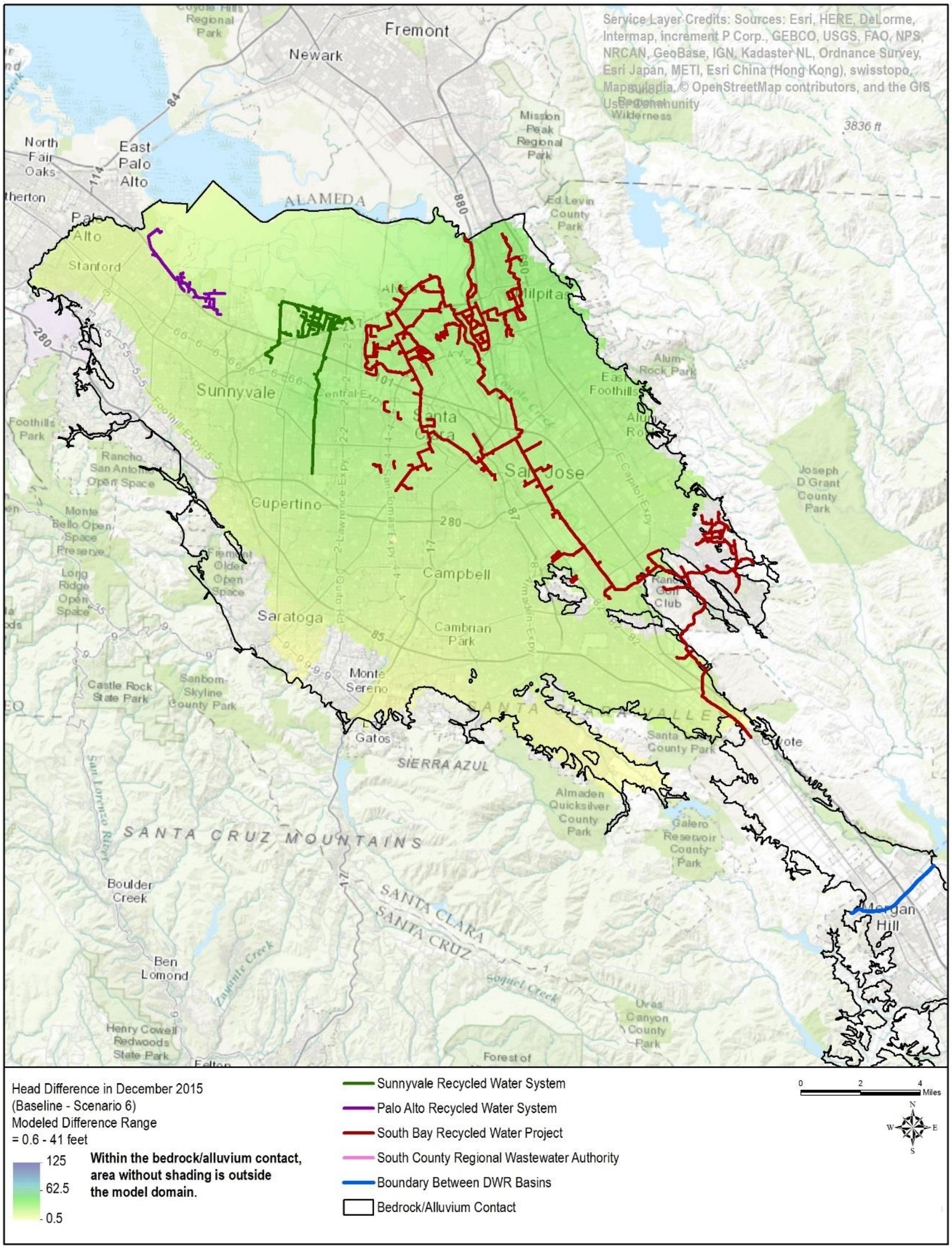

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapmyindia, © OpenStreetMap contributors, and the GIS User Community
Fremont
Newark
East Palo Alto
Palo Alto
Stanford
Sunnyvale
Santa Clara
San Jose
Milpitas
Cupertino
Campbell
Saratoga
Cambrian Park
Monte Sereno
Los Gatos
Coyote
Morgan Hill
SANTA CRUZ MOUNTAINS
SIERRA AZUL
SANTA CLARA VALLEY
Head Difference in December 2015
(Baseline - Scenario 6)
Modeled Difference Range
= 0.6 - 41 feet
125
62.5
0.5
Within the bedrock/alluvium contact, area without shading is outside the model domain.
Sunnyvale Recycled Water System
Palo Alto Recycled Water System
South Bay Recycled Water Project
South County Regional Wastewater Authority
Boundary Between DWR Basins
Bedrock/Alluvium Contact
0
2
4
Miles
N
W
E
S

Figure 44. Simulated Groundwater Level Difference due to Reduced Recycled Water in Santa Clara Plain

9.3 Santa Clara Plain Model Results Compared to the Groundwater Level Evaluation

The Santa Clara Plain model results demonstrate how benefits from individual District activities propagate throughout the hydrogeologically connected area of the Unconsolidated Alluvium of the Santa Clara Plain. The model results confirm and supplement demonstration of benefits by the groundwater level evaluation.

9.3.1 Santa Clara Plain Model Results where Groundwater Level Trends Do Not Fully Demonstrate Benefits

The model provides supplemental information in several areas where measured groundwater level trends do not fully demonstrate benefits from one or both District activities of managed recharge and treated water deliveries. These include portions of the service areas of Mountain View, Santa Clara, San Jose Water Company, Palo Alto, and Stanford.

In most of these areas, groundwater level trends for evaluation of managed recharge or treated water only demonstrate benefits during overlapping evaluation periods when benefits from the two activities cannot be distinguished. While the groundwater level trend evaluation demonstrates benefit from a District activity, the groundwater model scenarios can demonstrate benefit from each specific District activity. In these areas, the groundwater level trend evaluation only demonstrates that the area should be in a benefit zone while the model scenarios can attribute specific District activities to the zone.

Several areas in Mountain View, Santa Clara, and San Jose Water Company North have increasing groundwater level trends for evaluation of managed recharge or treated water only during overlapping evaluation periods when benefits from the two activities cannot be distinguished. There is also an area of Santa Clara where there are no groundwater data during periods to evaluate benefits from treated water deliveries. The modeled groundwater level differences between the baseline (Scenario 1) and both the reduced treated water delivery (Scenario 2) and the reduced managed recharge (Scenario 5) show the benefit in these areas are similar to surrounding areas. Therefore, the conclusion that evaluations of groundwater level trends in surrounding areas demonstrating benefit from both activities could be extrapolated to these areas is confirmed.

In the Palo Alto and Stanford areas, the groundwater level data evaluation is able to distinguish benefits from treated water deliveries in the Stanford area but otherwise is not able to distinguish benefits between the treated water and managed aquifer recharge activities. The modeled groundwater level differences between the baseline (Scenario 1) and both the reduced treated water delivery (Scenario 2) and the reduced managed recharge (Scenario 5) show similar benefits to the Palo Alto and Stanford areas, which demonstrates that this area benefits from both District activities.

In the San Jose Water Company Los Gatos area, measured groundwater level trends associated with treated water deliveries are stable only in an evaluation period that overlaps with managed recharge, making it difficult to definitively demonstrate the benefit from treated water deliveries. The modeled groundwater level differences between the baseline (Scenario 1) and the reduced treated water delivery (Scenario 2) in this area are similar to model results in other areas where groundwater level trends demonstrates benefit from treated water deliveries, which shows that this area also benefits from the treated water delivery activity.

9.3.2 Santa Clara Plain Model Results in Treated Water Delivery Areas

In-lieu recharge benefits to groundwater users are assumed to exist in areas receiving treated water delivery regardless of geology (Section 7.2). Figure 42 also demonstrates these benefits in these areas within the Unconsolidated Alluvium based on model results. The Santa Clara Plain model does not cover treated water delivery areas in the Santa Clara Formation and bedrock.

9.3.3 Areas not Covered by Santa Clara Plain Model

The Santa Clara Plain model does not include several areas where the groundwater level data evaluation does not demonstrate benefits from a District activity or groundwater level data are not available. These areas include Coyote Valley and the Santa Clara Formation on the west side of the subbasin.

In the Coyote Valley, groundwater level trends do not demonstrate a benefit from treated water deliveries. The Santa Clara Plain model boundary is at Coyote Narrows at the north end of Coyote Valley. Therefore, the model does not provide any information on the Coyote Valley. The groundwater level trend evaluate does demonstrate a benefit from managed recharge that occurs in this area.

Groundwater level data are not available in the Santa Clara Formation, including areas of Stanford, Purissima Hills, Palo Alto, Los Altos, Saratoga, and Los Gatos. The Santa Clara Plain model does not extend to include the Santa Clara Formation, and therefore does not provide any information showing benefits extend from the Unconsolidated Alluvium into Santa Clara Formation. The model sets a mountain front recharge boundary condition at the boundary of the Santa Clara Formation and the Unconsolidated Alluvium that represents natural recharge based on climatic conditions. The boundary condition does not account for operations of District managed recharge and therefore the District does not have an operational assumption that managed recharge is occurring in the Santa Clara Formation. However, treated water deliveries do extend into areas of the Santa Clara Formation. The groundwater model is unable to demonstrate the extent of benefits from these treated water deliveries into the rest of the Santa Clara Formation since it is outside the model area. The Santa Clara Plain model also does not simulate flow in bedrock areas and therefore is unable to demonstrate benefits extending from District activities in bedrock.

The Santa Clara Plain model also does not include the Evergreen area of San Jose Municipal Water, but the groundwater level data evaluation demonstrated benefits from managed recharge for that area. The District delivers treated water to that area so the area also benefits from that District activity.

9.4 Llagas Model Simulations

The District ran simulations using the Llagas Subbasin groundwater model following the approach outlined above. One of the main assumptions implemented in this model is that the domain covers the Unconsolidated Alluvium east of bedrock outcrops but does not cover most of the Uvas-Chesbro area. The District memo (Abuye, 2016) included as Appendix I documents these models. The Study uses modeling that evaluates managed recharge of local runoff (Scenario 1), managed recharge of imported water (Scenario 2), and recycled water deliveries (Scenario 4) separately. The Study does not use Scenario 3 evaluating effects of all managed recharge because recharge of local runoff and imported water are evaluated separately to account for the fact that the lower Llagas system is not connected to imported water. All runs simulate historical conditions for climate from 1987-2015.

9.4.1 Baseline

The baseline run simulates historical conditions from 1987-2015 for pumping and managed recharge. Results from all other scenarios are compared to this scenario to evaluate the extent of benefit from a specific District activity. This comparison is done by subtracting groundwater level results at the end of each of Scenarios 1, 2 and 4 from the results at the end of this baseline run (Figure 45 through Figure 47). A positive difference in the groundwater levels indicate a benefit from the District activity because the baseline run includes the District activity as fully implemented historically. The Study evaluates each map of the groundwater level difference in 2015 for demonstrated extent of benefits. Yellow represents the minimum groundwater level difference of 0.5 feet across all scenarios when compared to the baseline scenario. Dark blue represents the maximum groundwater level difference of 303 feet across all scenarios when compared to the baseline scenario.

9.4.2 Reduced Managed Aquifer Recharge of Local Runoff

Scenario 1 eliminates managed recharge of local runoff at the Upper Llagas and Lower Llagas systems from 2005-2015. Figure 45 shows the groundwater level difference between the Baseline scenario and Scenario 1. This figure shows managed recharge of local water resulted in increases in groundwater levels throughout the modeled domain of the Llagas Subbasin ranging from 25 to 303 feet. Since the model domain does not include the Uvas Chesbro area, the model does not simulate the managed recharge of local runoff that occurs in Uvas and Llagas Creeks in that area.

9.4.3 Reduced Managed Aquifer Recharge of Imported Water Runoff

Scenario 2 eliminates managed recharge of imported water at the Upper Llagas system from 2005-2015. Figure 46 shows the groundwater level difference between the Baseline scenario and Scenario 2. This figure shows increases in groundwater levels from eleven years of managed recharge of local runoff throughout the modeled domain of the Llagas Subbasin ranging from 0.9 to 108 feet.

9.4.4 Reduced Recycled Water

Scenario 4 simulates reduced recycled water deliveries by assuming a reduction in these deliveries would be made up for with increased pumping. This was accomplished in the model by increasing pumping by the recycled water delivery quantities to decrease in-lieu recharge from recycled water deliveries. Increased pumping is distributed between 58 pumping wells with 0.5 mile of the South County Regional Wastewater Authority recycled water pipeline. Figure 45 shows the groundwater level difference between the Baseline scenario and Scenario 4. This figure shows increases in groundwater levels from recycled water deliveries throughout the modeled domain of the Llagas Subbasin ranging from 0.5 to 11 feet. However, groundwater level differences throughout the subbasin are much smaller than differences for the eliminated managed recharge of local runoff (Scenario 1) and eliminated managed recharge of imported water (Scenario 2) due to the smaller volume of recycled water delivered. This confirms that District in-lieu recharge activities with relatively small deliveries, such as recycled water and untreated surface water, have benefits throughout the hydrogeologically connected area. However, benefits will be difficult to demonstrate with groundwater level data.

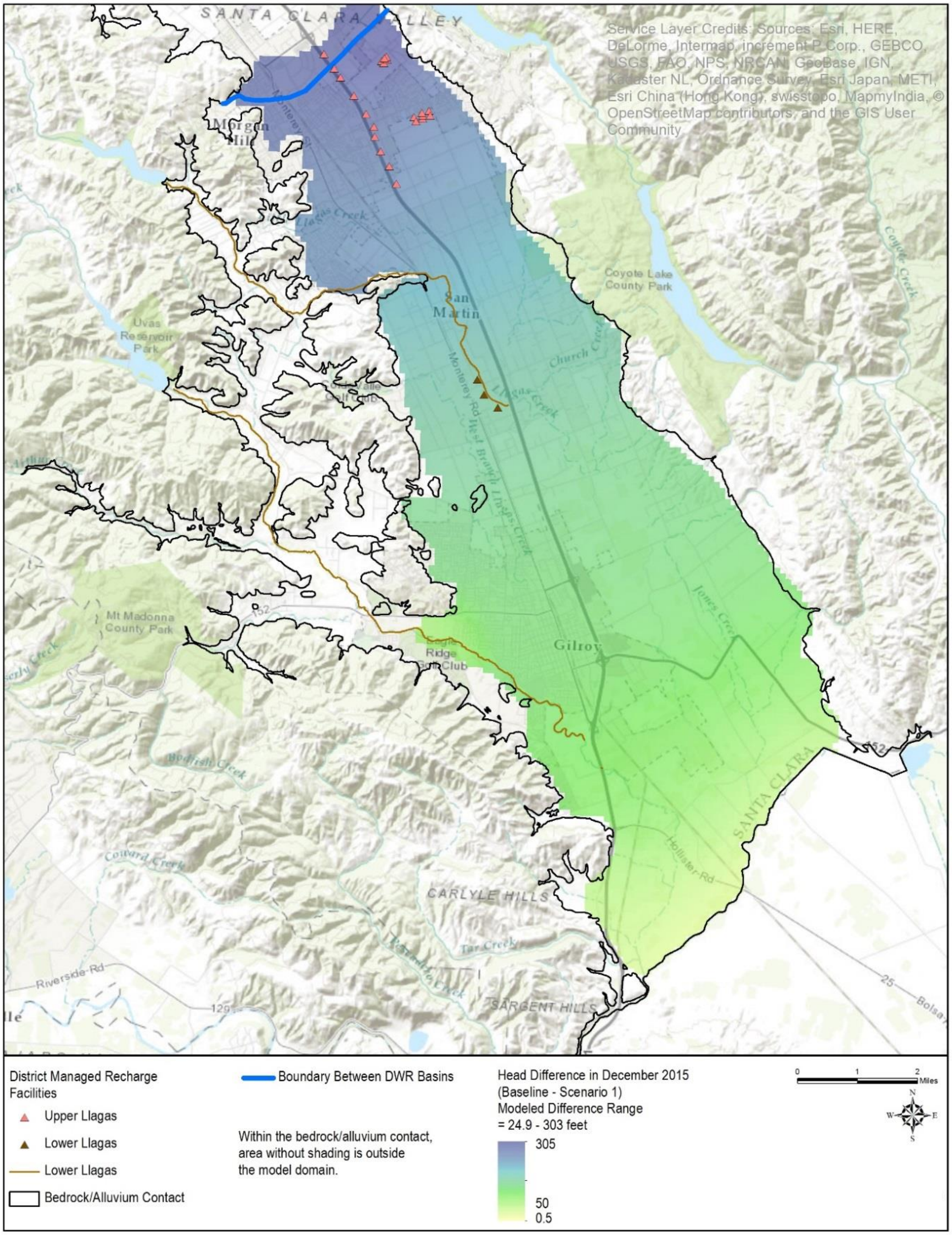
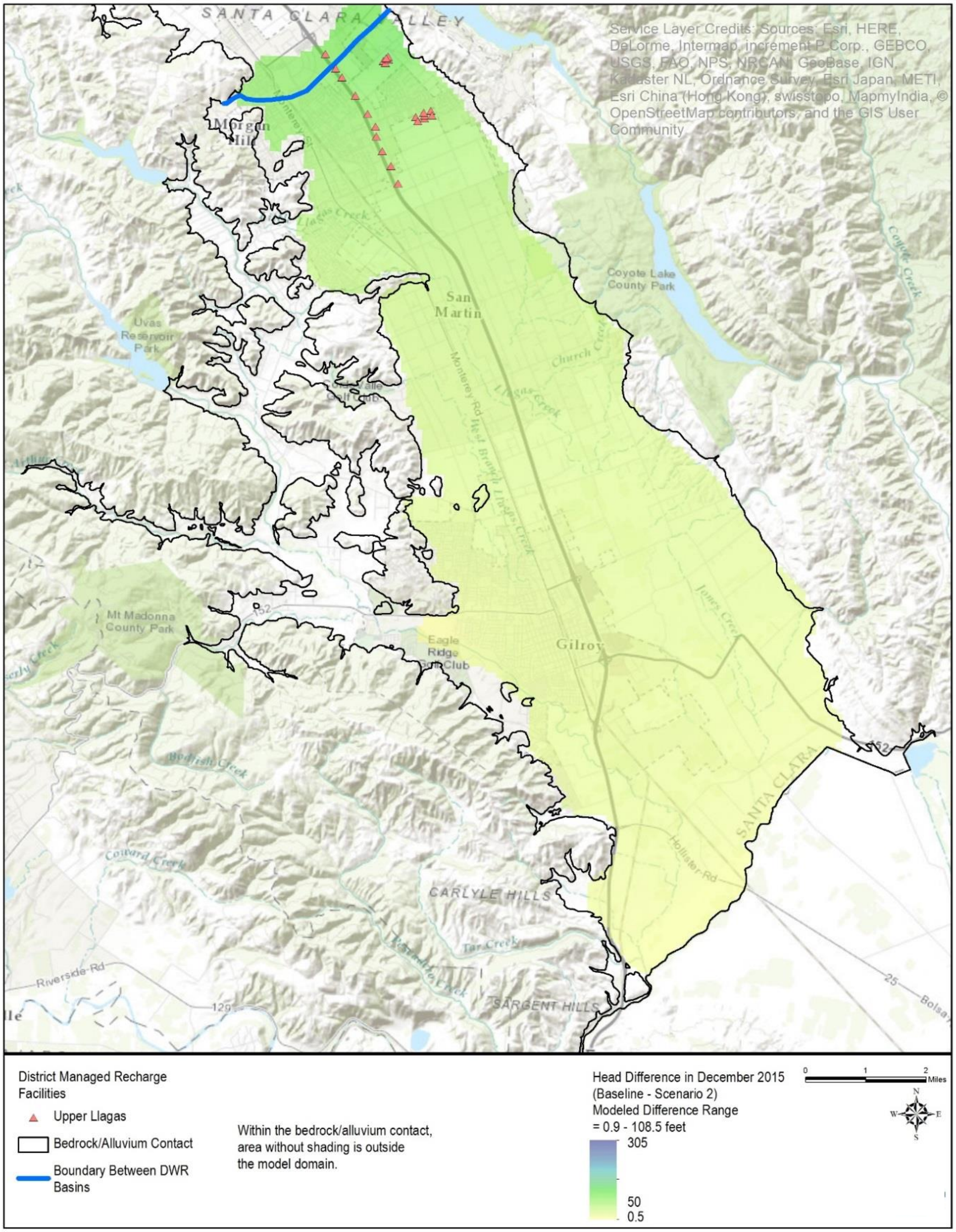

SANTA CLARA VALLEY
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Morgan Hill
Llagas Creek
Coyote Lake County Park
Coyote Creek
San Martin
Uvas Reservoir Park
Church Creek
Llagas Creek
Monterey Rd
West Branch Llagas Creek
Mt Madonna County Park
Eagle Ridge Golf Club
Gilroy
Jones Creek
Bodfish Creek
SANTA CLARA
Hollister Rd
Coward Creek
CARLYLE HILLS
Tar Creek
Riverside Rd
SARGENT HILLS
Bolsa
District Managed Recharge Facilities
Upper Llagas
Lower Llagas
Lower Llagas
Bedrock/Alluvium Contact
Boundary Between DWR Basins
Within the bedrock/alluvium contact, area without shading is outside the model domain.
Head Difference in December 2015 (Baseline - Scenario 1)
Modeled Difference Range = 24.9 - 303 feet
305
50
0.5
0
1
2
Miles
N
W
E
S

Figure 45. Simulated Groundwater Level Difference due to Reduced Managed Recharge of Local Runoff in Llagas Subbasin



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Within the bedrock/alluvium contact, area without shading is outside the model domain.

Figure 46. Simulated Groundwater Level Difference due to Reduced Managed Recharge of Imported Water in Llagas Subbasin

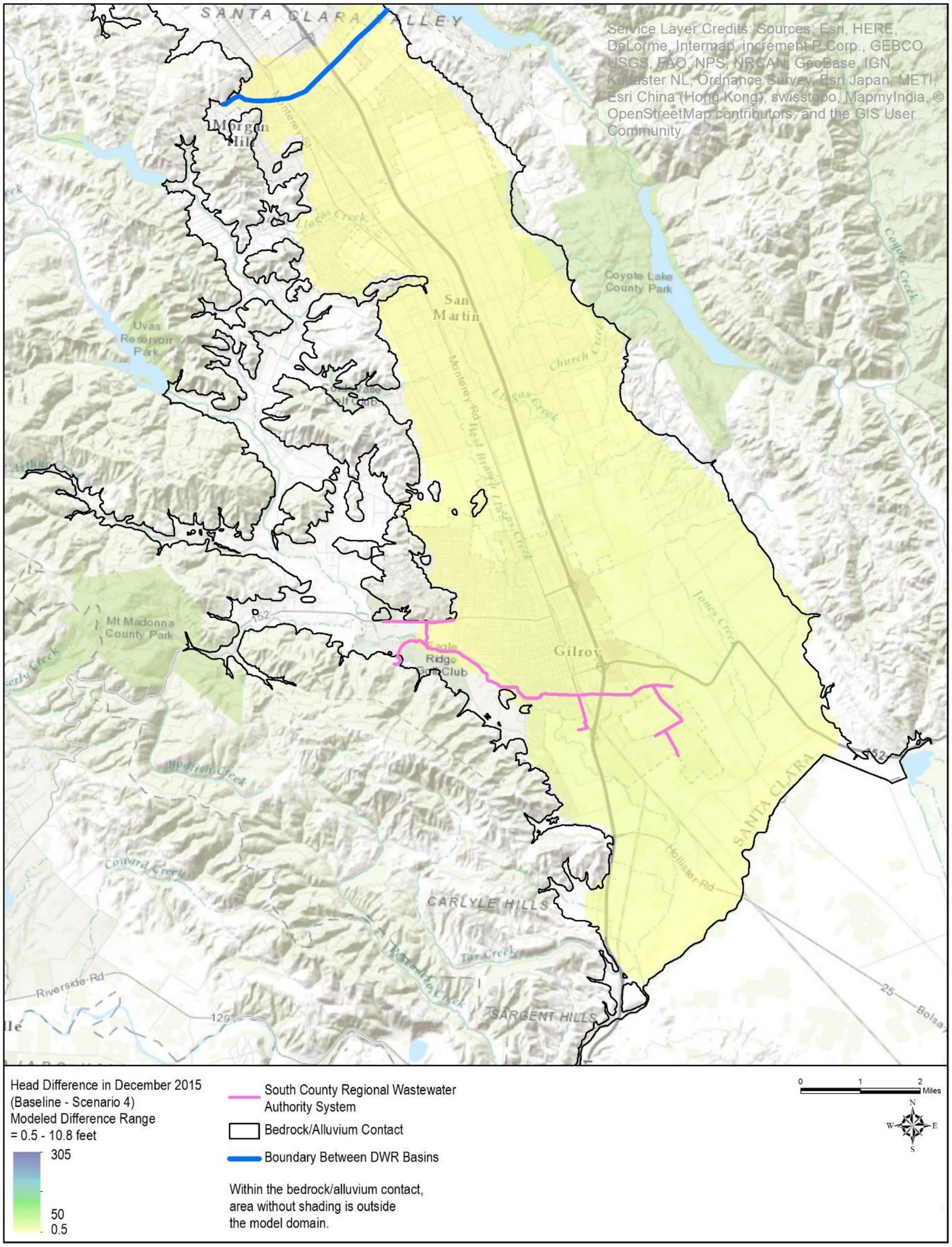

SANTA CLARA VALLEY
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Morgan Hill
Llagas Creek
San Martin
Coyote Lake County Park
Coyote Creek
Uvas Reservoir Park
Church Creek
Monterey Rd
West Branch Llagas Creek
Mt Madonna County Park
152
Eagle Ridge Golf Club
Gilroy
Jones Creek
SANTA CLARA
Bodfish Creek
Hollister Rd
Coward Creek
CARLYLE HILLS
Tar Creek
Riverside Rd
129
SARGENT HILLS
25
Bolsa
Head Difference in December 2015
(Baseline - Scenario 4)
Modeled Difference Range
= 0.5 - 10.8 feet
305
50
0.5
South County Regional Wastewater Authority System
Bedrock/Alluvium Contact
Boundary Between DWR Basins
Within the bedrock/alluvium contact, area without shading is outside the model domain.
0
1
2
Miles
N
W
E
S

Figure 47. Simulated Groundwater Level Difference due to Reduced Recycled Water in Llagas Subbasin

9.5 Llagas Model Results Compared to Groundwater Level Evaluation

While the groundwater evaluation evaluates managed recharge of local runoff and imported water together, the model results demonstrate how benefits from managed recharge of local runoff and imported water propagate throughout the hydrogeologically connected area of the subbasin. The model results supplement demonstration of benefits in pumping areas by the groundwater level evaluation.

9.5.1 Area not Covered by Llagas Model

The model does not the cover the Uvas-Chesbro- area where the groundwater level data evaluation does not demonstrate benefits from a District activity or groundwater level data are not available. The model only simulates the area east of the bedrock outcrops in the Llagas Subbasin that separates the Uvas-Chesbro area from the rest of the basin. Therefore, the model does not provide any information showing that benefits extend from managed recharge of imported water occurring east of the bedrock outcrops to the Uvas-Chesbro area. Managed recharge of local water occurs in the Uvas-Chesbro area and is assumed to benefit the hydrogeologically connected Unconsolidated Alluvium in that area.The Llagas model also does not simulate flow in bedrock areas and therefore is unable to demonstrate benefits extending from District activities in bedrock.

10 GROUNDWATER BENEFIT ZONES

We conclude the following from the Study evaluation to guide proposed groundwater benefit zones.

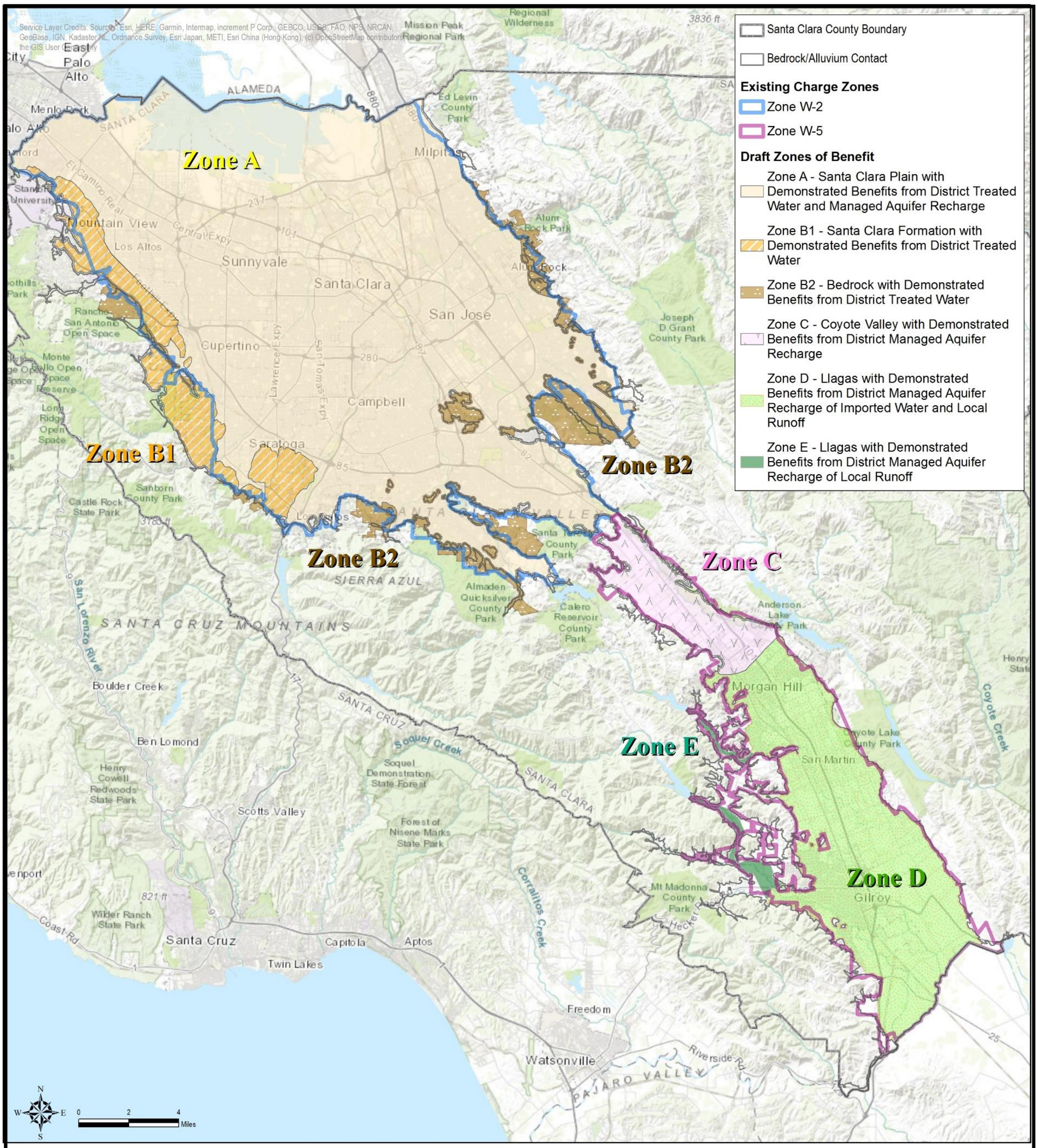
1. District recharge activities are located in alluvium that provides hydrogeologic connection throughout the Santa Clara and Llagas Subbasins.
2. District recharge activities have improved the water balance in hydrogeologically connected areas over time.
3. Groundwater level data and numerical groundwater modeling results demonstrate that benefits from District activities extend throughout hydrogeologically connected areas of Unconsolidated Alluvium where the District activities are located.
4. The groundwater level data do not conclusively demonstrate that benefits of District treated water deliveries in the Santa Clara Plain extend south into Coyote Valley as Coyote Narrows may restrict groundwater flow between the two management areas.
5. Groundwater level data and modeling results are not available to evaluate whether benefits from District activities in the Unconsolidated Alluvium of the Santa Clara Plain extend into the Santa Clara Formation located on the west side of the Santa Clara Plain.
6. District treated water delivery reduces groundwater demand in the Santa Clara Formation thereby improving the groundwater supply. It is reasonable to conclude that the Santa Clara Formation consists of hydrogeologically connected alluvium so District in-lieu recharge activities in the Santa Clara Formation benefit connected areas of the Santa Clara Formation. However, the uncertainty of this conclusion is higher than a similar conclusion for the Unconsolidated Alluvium due to lack of groundwater level data and numerical groundwater modeling.
7. Groundwater level data are not available to evaluate whether benefits from District activities in alluvium (Unconsolidated Alluvium or Santa Clara Formation) extend into bedrock. However, bedrock areas receiving District treated water supplies benefit from in-lieu recharge to those areas that reduce groundwater pumping from bedrock fractures even though there is a lack of groundwater level data and numerical groundwater modeling for these areas. However, bedrock fractures may be limited in areal extent, so the benefit is not considered to extend beyond the bedrock areas receiving District treated water.
8. Groundwater level data and modeling results are not available to demonstrate that managed recharge of imported water in the Llagas Subbasin valley floor benefits the narrow alluvium along Llagas and Uvas Creeks downstream of District reservoirs and upstream of the valley floor. However, the alluvium along these creeks does benefit from District releases of local runoff for managed recharge.
9. Recycled water and untreated surface water deliveries are too small relative to other District activities to evaluate benefits with groundwater level data. Modeling results of

in-lieu recharge from recycled water demonstrate that benefits from these small activities have benefits throughout hydrogeologically connected areas.

Based on these conclusions, the boundaries used to define the proposed zones are as follows:

1. Bedrock/Alluvium contact
2. DWR basin boundary approximating groundwater divide between Santa Clara and Llagas Subbasins.
3. Coyote Narrows between Santa Clara Plain and Coyote Valley.
4. Santa Clara Formation outcrops.
5. Retailer areas where District treated water is delivered
6. Narrows between bedrock outcrops in Llagas Subbasin
7. Western boundaries of Morgan Hill and Gilroy.
8. Constrictions where alluvial channels are upstream of areas hydrogeologically connected to District activities.

Figure 48 presents the proposed groundwater benefit zones.


Santa Clara County Boundary
Bedrock/Alluvium Contact
Existing Charge Zones
Zone W-2
Zone W-5
Draft Zones of Benefit
Zone A - Santa Clara Plain with Demonstrated Benefits from District Treated Water and Managed Aquifer Recharge
Zone B1 - Santa Clara Formation with Demonstrated Benefits from District Treated Water
Zone B2 - Bedrock with Demonstrated Benefits from District Treated Water
Zone C - Coyote Valley with Demonstrated Benefits from District Managed Aquifer Recharge
Zone D - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Imported Water and Local Runoff
Zone E - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Local Runoff
Zone A
Zone B1
Zone B2
Zone B2
Zone C
Zone D
Zone E
Mountain View
Sunnyvale
Santa Clara
San Jose
Cupertino
Campbell
Saratoga
Milpitas
Morgan Hill
San Martin
Gilroy
Santa Cruz
Watsonville
SANTA CRUZ MOUNTAINS
0
2
4
Miles
N
S
E
W

These mapped zones may be revised further to account for administrative requirements. These zones will also require additional revision to facilitate the development of legal descriptions for the zones. This will involve approximating the boundaries to reduce the number of line segments that require a metes and bounds description.

Zone A: Benefits from Managed Aquifer Recharge, Treated Water Deliveries, and Recycled Water Programs in the Santa Clara Plain

Zone A consists of areas overlying Unconsolidated Alluvium, and benefits from District treated water deliveries, managed aquifer recharge using local runoff and imported water, and recycled water programs. Zone A excludes areas of mapped Santa Clara Formation where benefits from managed aquifer recharge activities are not evaluated due to limited well data. The northern boundary is the San Mateo-Santa Clara County line and the southern boundary is the boundary between existing Zones W-2 and W-5.

Zone B1: Benefits from Treated Water Deliveries in the Santa Clara Formation

Zone B1 consists of areas within the Santa Clara Formation that are hydrogeologically connected to areas where District treated water is delivered. Data are not available to demonstrate benefits from the District's managed aquifer recharge. Foothill Expressway is used to approximate the eastern extent of the Santa Clara Formation underlying the alluvial outcrop. In addition to approximating this geological boundary, this also lines up with the District treated water delivery area for the Cal Water Los Altos service area; the treated water delivery provides in-lieu benefits for this area of the zone.

Zone B2: Benefits from Treated Water Deliveries in Bedrock

Zone B2 consists of areas with underlying bedrock where District treated water is delivered. Bedrock areas outside the treated water delivery areas are excluded from this and other zones because bedrock fractures with accessible groundwater may be limited in areal extent. Therefore, the benefit is not considered to extend beyond the treated water delivery area. Zone B2 includes many separate areas where bedrock underlies District treated water delivery areas.

All zones benefit from long-term water conservation and groundwater protection activities

Zone C: Benefits from Managed Aquifer Recharge in Coyote Valley

Zone C consists of Unconsolidated Alluvium in the Coyote Valley where benefits from managed aquifer recharge using both local runoff and imported water are demonstrated. The northern boundary is the boundary between existing Zones W-2 and W-5. The southern boundary is the boundary between the California Department of Water Resources (DWR) Santa Clara and Llagas subbasins that approximates the groundwater divide separating the two basins.

Zone D: Benefits from Managed Aquifer Recharge (Local Runoff and Imported Water) and Recycled Water Programs in the Llagas Subbasin

This zone consists of areas overlying Unconsolidated Alluvium in the Llagas Subbasin where benefits from managed aquifer recharge of imported and local water are demonstrated. The zone contains the entire retail service areas of the cities of Morgan Hill and Gilroy. The northern boundary is the boundary between the Santa Clara and Llagas subbasins as defined by DWR. The southern boundary is based on the Santa Clara-San Benito County line corresponding with the southern extent of

Zone E: Benefits from Managed Aquifer Recharge of Local Runoff in Uvas/Llagas Creek Bottoms

This zone consists of areas overlying Unconsolidated Alluvium along upper Uvas and Llagas creeks where District managed aquifer recharge of local runoff occurs. This includes Unconsolidated Alluvium west of the cities of Morgan Hill and Gilroy that are deposited along Llagas Creek and Uvas Creek below the District's Chesbro and Uvas Reservoirs. These narrow alluvial channels are surrounded by bedrock outcrops and are upstream of the main valley floor. The boundary between proposed Zones D and E is based upon the location where data and groundwater model results are available to demonstrate benefit from imported water. Alluvial channels for tributaries that are not directly downstream of the District's reservoirs are excluded from this zone.

H:\Santa Clara VWD\Groundwater_Charge_Zone_Study\GIS\FINAL_MXD_FILES\zoneMAPS\ZOB_figures\3_Draft_Zones_of_Benefit.mxd

Figure 48. Proposed Groundwater Benefit Zones

10.1 Zone A Benefits from Managed Aquifer Recharge, Treated Water Deliveries, and Recycled Water in the Santa Clara Plain

Zone A consists of areas overlying Unconsolidated Alluvium, and benefits from District treated water deliveries, managed aquifer recharge using local runoff and imported water, and recycled water programs. Zone A excludes areas of mapped Santa Clara Formation where benefits from managed aquifer recharge activities are not evaluated due to limited well data. The northern boundary is the San Mateo-Santa Clara County line and the southern boundary is the boundary between existing Zones W-2 and W-5.

10.2 Zone B1 Benefits from Treated Water Deliveries in the Santa Clara Formation

Zone B1 consists of areas within the Santa Clara Formation that are hydrogeologically connected to areas where District treated water is delivered. Data are not available to demonstrate benefits from the District's managed aquifer recharge. Foothill Expressway is used to approximate the eastern extent of the Santa Clara Formation underlying the alluvial outcrop. In addition to approximating this geological boundary, this also lines up with the District treated water delivery area for the Cal Water Los Altos service area; the treated water delivery provides in-lieu benefits for this area of the zone.

10.3 Zone B2 Benefits from Treated Water Deliveries in Bedrock

Zone B2 consists of areas with underlying bedrock where District treated water is delivered. Bedrock areas outside the treated water delivery areas are excluded from this and other zones because bedrock fractures with accessible groundwater may be limited in areal extent. Therefore, the benefit is not considered to extend beyond the treated water delivery area. Zone B2 includes many separate areas where bedrock underlies District treated water delivery areas.

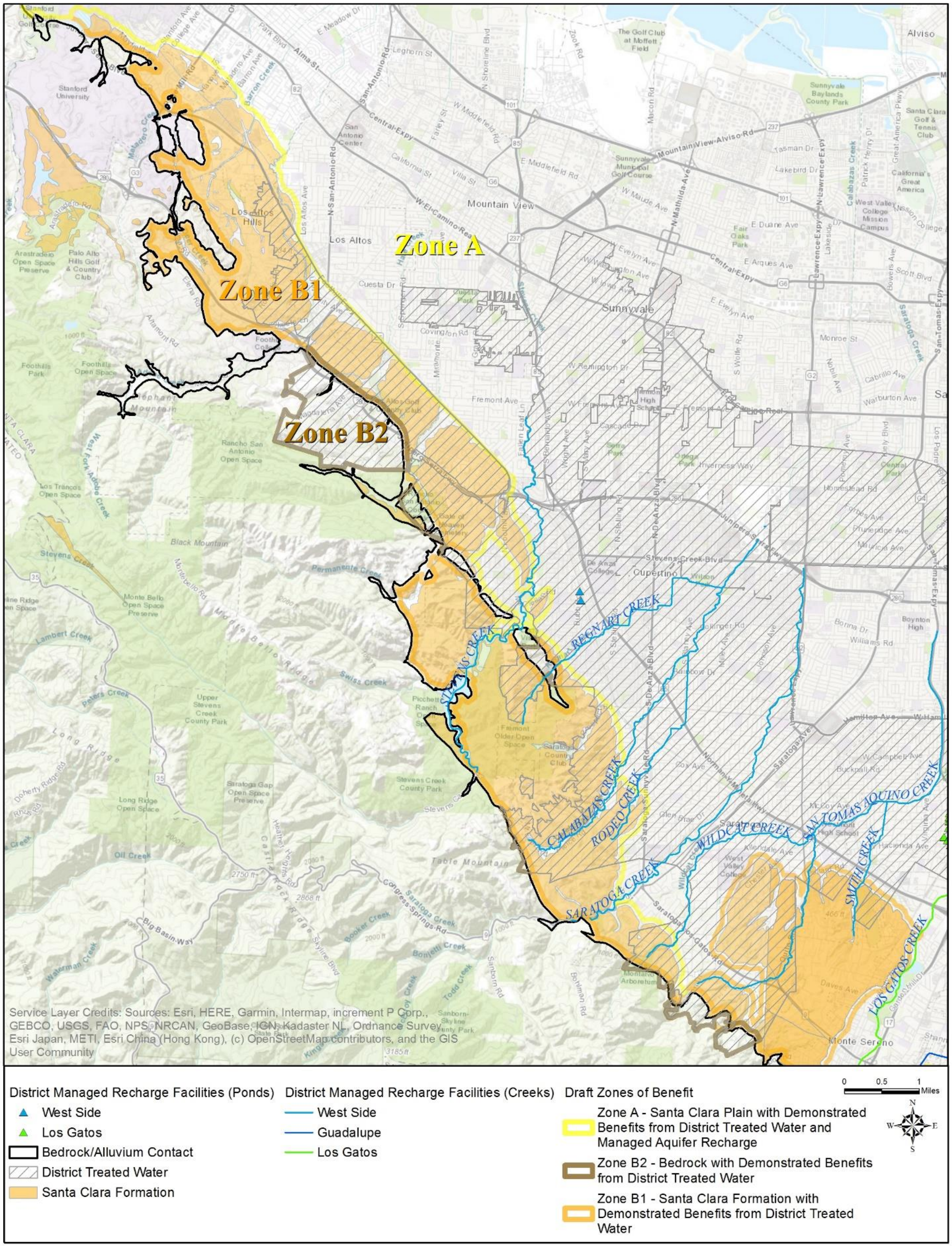

Zone A
Zone B1
Zone B2
Mountain View
Los Altos
Sunnyvale
Cupertino
Stanford University
Los Altos Hills
Saratoga Creek
Calabazas Creek
Rodeo Creek
Regnart Creek
Wildcat Creek
San Tomas Aquino Creek
Smith Creek
Los Gatos Creek
Stevens Creek
Permanente Creek
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
District Managed Recharge Facilities (Ponds)
West Side
Los Gatos
Bedrock/Alluvium Contact
District Treated Water
Santa Clara Formation
District Managed Recharge Facilities (Creeks)
West Side
Guadalupe
Los Gatos
Draft Zones of Benefit
Zone A - Santa Clara Plain with Demonstrated Benefits from District Treated Water and Managed Aquifer Recharge
Zone B2 - Bedrock with Demonstrated Benefits from District Treated Water
Zone B1 - Santa Clara Formation with Demonstrated Benefits from District Treated Water
0
0.5
1
Miles
N
E
S
W

Figure 49. Zones A and B in Santa Clara Formation on Westside of Santa Clara Subbasin

10.4 Zone C Benefits from Managed Aquifer Recharge in Coyote Valley

Zone C consists of Unconsolidated Alluvium in the Coyote Valley where benefits from managed aquifer recharge using both local runoff and imported water are demonstrated. The northern boundary is the boundary between existing Zones W-2 and W-5. The southern boundary is the boundary between the California Department of Water Resources (DWR) Santa Clara and Llagas Subbasins that approximates the groundwater divide separating the two basins.

10.5 Zone D Benefits from Managed Aquifer Recharge (Local Runoff and Imported Water) and Recycled Water in the Llagas Subbasin

Zone D consists of areas overlying Unconsolidated Alluvium in the Llagas Subbasin where benefits from managed aquifer recharge of imported and local water are demonstrated. The zone contains the entire retail service areas of the cities of Morgan Hill and Gilroy because groundwater pumped from areas where benefits are demonstrated are delivered to these hydrogeologically connected areas within Morgan Hill and Gilroy. The northern boundary is the boundary between the Santa Clara and Llagas Subbasins as defined by DWR. The southern boundary is based on the Santa Clara-San Benito County line corresponding with the southern extent of Unconsolidated Alluvium in Santa Clara County.

10.6 Zone E Llagas Benefits from Managed Aquifer Recharge of Local Runoff in Uvas/Llagas Creek

Zone E consists of areas overlying Unconsolidated Alluvium along upper Uvas and Llagas Creeks where District managed aquifer recharge of local runoff occurs. This includes Unconsolidated Alluvium west of the cities of Morgan Hill and Gilroy that are deposited along Llagas Creek and Uvas Creek below the District’s Chesbro and Uvas Reservoirs. These narrow alluvial channels are surrounded by bedrock outcrops and are upstream of the main valley floor. The boundary between proposed Zones D and E is based upon the location where data and groundwater model results are available to demonstrate benefit from imported water and the boundaries of retail service areas of the cities of Morgan Hill and Gilroy. Alluvial channels for tributaries that are not directly downstream of the District’s reservoirs are excluded from this zone.

10.7 Assignment of District Activities to Zones

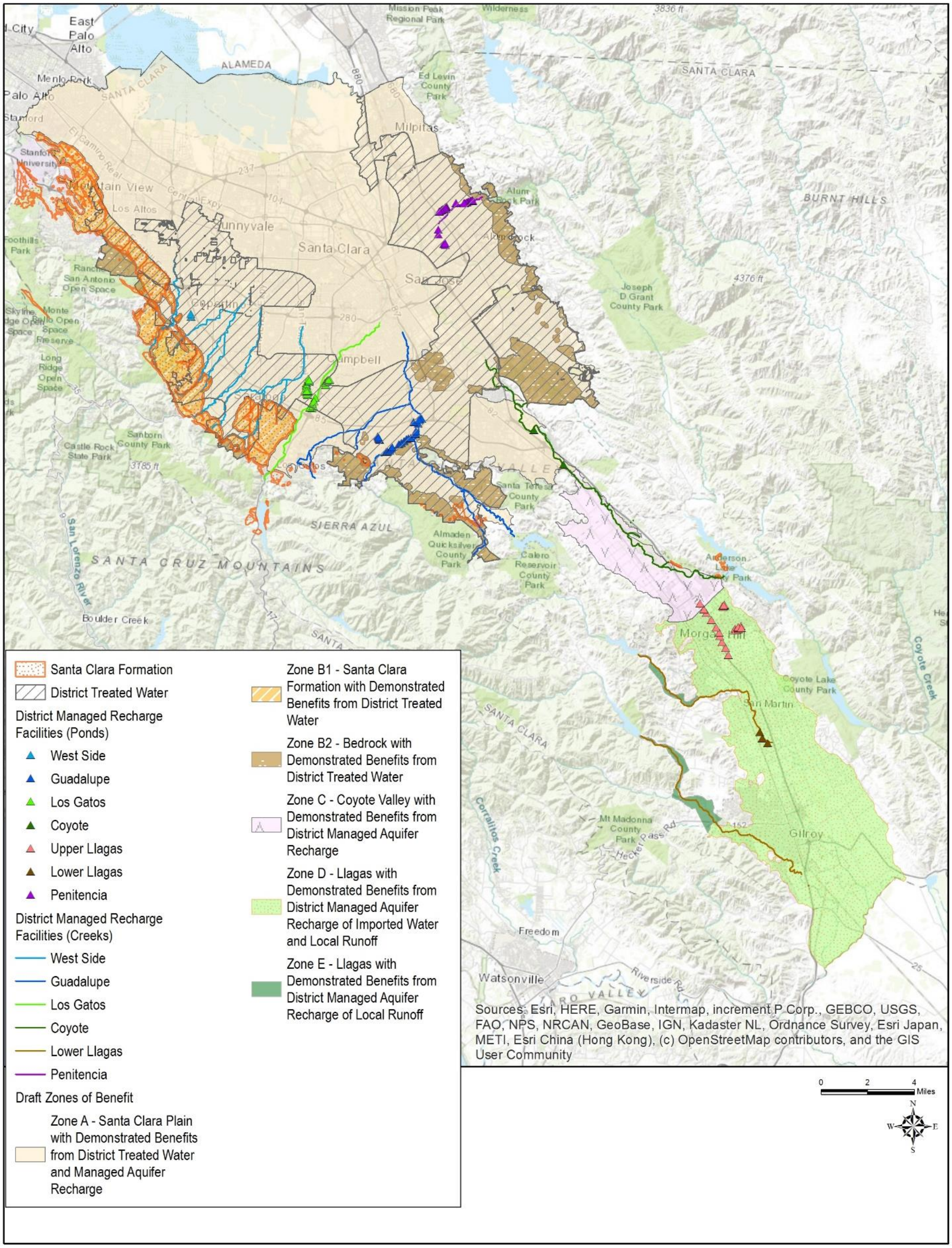
The Study proposes groundwater benefit zones primarily based on District activities of managed aquifer recharge and treated water deliveries. Figure 50 shows managed recharge facilities and treated water delivery areas overlying the proposed groundwater benefit zones.

Although the groundwater benefit zones are based on the managed aquifer recharge and treated water deliveries that provide the largest District contributions to the water budget, other District activities provide benefits to groundwater users in the zones. Activities such as recycled water and untreated surface water deliveries can be assigned to zones they are located within, as shown in Figure 51. The modeling runs for recycled water did show groundwater level increases from in-lieu recharge provided by recycled water throughout the Zone A and Zone D areas. Similarly, planned future activities can be assigned to zones where they are planned to be located such as indirect potable reuse in Zone A.

District activities such as conservation and groundwater protection benefit all groundwater users so are assigned to all groundwater benefit zones.

Table 10. District Activity Assignment to Zones

District Activity	Zones
Managed Recharge (Local Runoff)	A, C, D, E
Managed Recharge (Imported Water)	A, C, D
Treated Water Deliveries	A, B1, B2
Recycled Water	A, D
Untreated Surface Water Deliveries	A, C, D, E
Conservation	All
Groundwater Protection	All
Planned Indirect Potable Reuse	A


Santa Clara Formation
District Treated Water
District Managed Recharge Facilities (Ponds)
▲ West Side
▲ Guadalupe
▲ Los Gatos
▲ Coyote
▲ Upper Llagas
▲ Lower Llagas
▲ Penitencia
District Managed Recharge Facilities (Creeks)
West Side
Guadalupe
Los Gatos
Coyote
Lower Llagas
Penitencia
Draft Zones of Benefit
Zone A - Santa Clara Plain with Demonstrated Benefits from District Treated Water and Managed Aquifer Recharge
Zone B1 - Santa Clara Formation with Demonstrated Benefits from District Treated Water
Zone B2 - Bedrock with Demonstrated Benefits from District Treated Water
Zone C - Coyote Valley with Demonstrated Benefits from District Managed Aquifer Recharge
Zone D - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Imported Water and Local Runoff
Zone E - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Local Runoff
0
2
4
Miles
N
W
E
S
East Palo Alto
Menlo Park
Palo Alto
Stanford
Stanford University
Mountain View
Los Altos
Sunnyvale
Santa Clara
San Jose
Milpitas
Cupertino
Campbell
Los Gatos
Alum Rock
Morgan Hill
San Martin
Gilroy
Watsonville
Freedom
ALAMEDA
SANTA CLARA
SANTA CRUZ MOUNTAINS
SIERRA AZUL
BURNT HILLS
Mission Peak Regional Park
Ed Levin County Park
Joseph D Grant County Park
Sanborn County Park
Castle Rock State Park
Almaden Quicksilver County Park
Calero Reservoir County Park
Santa Teresa County Park
Anderson Lake County Park
Coyote Lake County Park
Mt Madonna County Park
Boulder Creek
San Lorenzo River
Corralitos Creek
Coyote Creek
PAJARO VALLEY

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 50: Managed Recharge Facilities and Treated Water Deliveries with Groundwater Benefit Zones

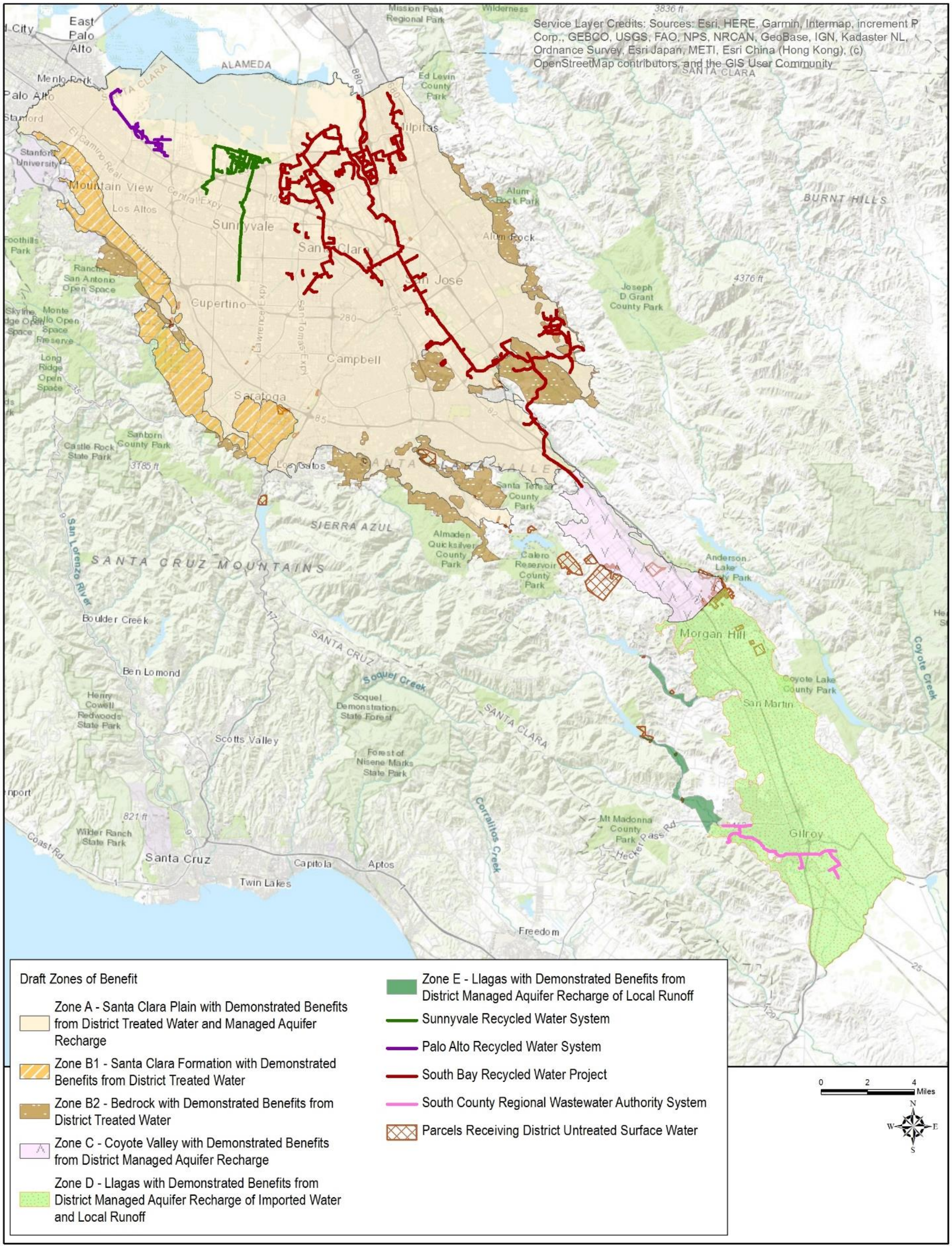

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Draft Zones of Benefit
Zone A - Santa Clara Plain with Demonstrated Benefits from District Treated Water and Managed Aquifer Recharge
Zone B1 - Santa Clara Formation with Demonstrated Benefits from District Treated Water
Zone B2 - Bedrock with Demonstrated Benefits from District Treated Water
Zone C - Coyote Valley with Demonstrated Benefits from District Managed Aquifer Recharge
Zone D - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Imported Water and Local Runoff
Zone E - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Local Runoff
Sunnyvale Recycled Water System
Palo Alto Recycled Water System
South Bay Recycled Water Project
South County Regional Wastewater Authority System
Parcels Receiving District Untreated Surface Water
0
2
4
Miles
N
S
E
W
East Palo Alto
Menlo Park
Palo Alto
Mountain View
Los Altos
Sunnyvale
Santa Clara
Milpitas
San Jose
Cupertino
Campbell
Saratoga
Los Gatos
Morgan Hill
San Martin
Gilroy
Santa Cruz
Capitola
Aptos
Scotts Valley
Boulder Creek
Ben Lomond
Freedom
SANTA CRUZ MOUNTAINS
SIERRA AZUL
BURNT HILLS
SANTA CLARA VALLEY

Figure 51:Recycled Water Systems and Parcels Receiving Untreated Surface Water with Groundwater Benefit Zones

10.8 SUMMARY OF SUPPORTING ANALYSES FOR GROUNDWATER BENEFIT ZONES

The recommendation of groundwater benefit zones is based on several analyses. This section summarizes which analyses are used to establish assignment of benefits from District activities to each recommended zone (Table 10). The analyses include:

- Mapping of treated water delivery area. The delivery of treated water is a substantial source of in-lieu recharge to the Santa Clara Subbasin as shown in Section 0. Groundwater users in the area where treated water is delivered benefit from the in-lieu recharge to the area where groundwater pumping for the area is reduced thereby improving groundwater conditions for the area. Mapping of treated water delivery areas is described in Section 7.1 with areas occurring in zones A, B1, and B2. Mapping of recycled water distribution systems and parcels receiving surface water are not used to establish zone areas because they are not contiguous areas, but benefits from these activities occur in hydrogeologically connected zones. The only area that is recommended as part of a groundwater benefit zone solely due to mapping of treated water delivery area is zone B2.
- Groundwater level data evaluation. The groundwater level data evaluation described in Section 8 evaluates benefits from District treated water and managed recharge activities during periods when groundwater levels would be expected to decline without District activities. If groundwater levels are stable or increasing during the period, benefit from the District activity is demonstrated. In some periods, groundwater levels demonstrate a benefit from District activities, but District treated water and managed recharge activities overlap so benefits from the specific activity cannot be identified. Declining groundwater levels during evaluation periods do not indicate a lack of benefit from District activities as declining groundwater levels are expected during the period and District activities may be reducing the decline. If a benefit from a District activity is demonstrated to an area during any evaluation period, the benefit to the area is demonstrated as long as the District activity continues based on the ongoing water budget benefits from District activities. The groundwater level data evaluation supports demonstration of benefits in zones A, C, and D.
- Modeling. As described in Section 9, simulations were performed with the Santa Clara Plain and Llagas Subbasin groundwater models to evaluated benefits from treated water deliveries, managed recharge with local supplies, managed recharge with imported supplies, and recycled water separately. Model results of groundwater levels are compared between a baseline run with all District activities occurring as they have

historically with runs that remove or reduce each of the District activities. This allows an evaluation of the benefits from each specific District activity separately. The model results also supplement the groundwater level data evaluation where groundwater level trends do not fully demonstrate benefits to an area from a specific activity. Modeling supports demonstration of benefits in zones A and D.

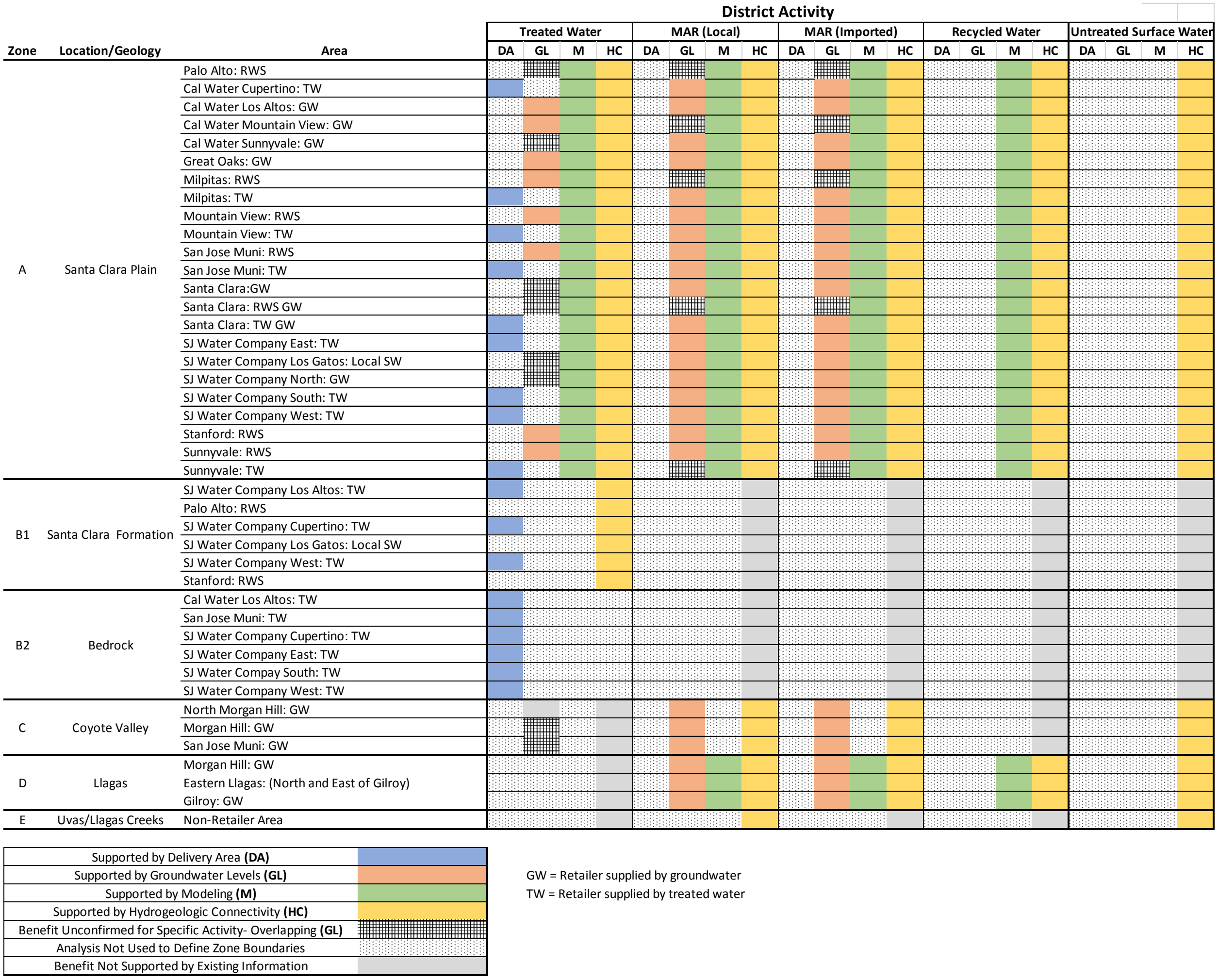
- Hydrogeologic connection. As described in Section 5, the Study maps hydrogeologic features that affect groundwater flow to define areas hydrogeologically connected to District activities that extend benefits from those activities beyond their immediate locations. Information about hydrogeologically connected areas supports inclusion of benefits in zones A, B1, C, D, and E. The only areas that are recommended as part of a groundwater benefit zone solely due to hydrogeologic connection is the area of zone B1 not receiving treated water and zone E where the District manages aquifer recharge by Uvas and Llagas Creeks with releases from Uvas and Chsbro Reservoirs.

Table 11 shows a summary of the supporting analyses for each District activity by zone. Table 12 provides additional detail by each pumping area used in the groundwater level evaluation.

Table 11. Supporting Analyses by Zone and District Activity

				Supporting Analysis		
Zone	**Location/Geology**	**District Activity**	**Delivery Area**	**Groundwater Levels**	**Modeling**	**Hydrogeologic Connectivity**
A	Santa Clara Plain	Treated Water	🟦	🟦	🟦	🟦
		Managed Aquifer Recharge (Local)		🟦	🟦	🟦
		Managed Aquifer Recharge (Imported)		🟦	🟦	🟦
		Recycled Water			🟦	🟦
		Untreated Surface Water				🟦
B1	Santa Clara Formation	Treated Water	🟦			🟦
B2	Bedrock	Treated Water	🟦			
C	Coyote Valley	Managed Aquifer Recharge (Local)		🟦		🟦
		Managed Aquifer Recharge (Imported)		🟦		🟦
		Untreated Surface Water				🟦
D	Llagas	Managed Aquifer Recharge (Local)		🟦	🟦	🟦
		Managed Aquifer Recharge (Imported)		🟦	🟦	🟦
		Recycled Water			🟦	🟦
		Untreated Surface Water				🟦
E	Uvas/Llagas Creeks	Managed Aquifer Recharge (Local)				🟦
		Untreated Surface Water				🟦

Table 12. Supporting Analyses by Pumping Area and District Activity



			District Activity																			
			Treated Water				MAR (Local)				MAR (Imported)				Recycled Water				Untreated Surface Water			
Zone	Location/Geology	Area	DA	GL	M	HC	DA	GL	M	HC	DA	GL	M	HC	DA	GL	M	HC	DA	GL	M	HC
A	Santa Clara Plain	Palo Alto: RWS	░	▦	🟩	🟨	░	▦	🟩	🟨	░	▦	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Cal Water Cupertino: TW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Cal Water Los Altos: GW	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Cal Water Mountain View: GW	░	🟧	🟩	🟨	░	▦	🟩	🟨	░	▦	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Cal Water Sunnyvale: GW	░	▦	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Great Oaks: GW	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Milpitas: RWS	░	🟧	🟩	🟨	░	▦	🟩	🟨	░	▦	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Milpitas: TW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Mountain View: RWS	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Mountain View: TW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		San Jose Muni: RWS	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		San Jose Muni: TW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Santa Clara:GW	░	▦	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Santa Clara: RWS GW	░	▦	🟩	🟨	░	▦	🟩	🟨	░	▦	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Santa Clara: TW GW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		SJ Water Company East: TW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		SJ Water Company Los Gatos: Local SW	░	▦	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		SJ Water Company North: GW	░	▦	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		SJ Water Company South: TW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		SJ Water Company West: TW	🟦	░	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Stanford: RWS	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Sunnyvale: RWS	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	🟧	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
		Sunnyvale: TW	🟦	░	🟩	🟨	░	▦	🟩	🟨	░	▦	🟩	🟨	░	░	🟩	🟨	░	░	░	🟨
B1	Santa Clara Formation	SJ Water Company Los Altos: TW	🟦	░	░	🟨	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜
		Palo Alto: RWS	░	░	░	🟨	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜
		SJ Water Company Cupertino: TW	🟦	░	░	🟨	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜
		SJ Water Company Los Gatos: Local SW	░	░	░	🟨	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜
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		Stanford: RWS	░	░	░	🟨	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜
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		SJ Water Company East: TW	🟦	░	░	░	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜	░	░	░	⬜
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C	Coyote Valley	North Morgan Hill: GW	░	⬜	░	⬜	░	🟧	░	🟨	░	🟧	░	🟨	░	░	░	⬜	░	░	░	🟨
		Morgan Hill: GW	░	▦	░	⬜	░	🟧	░	🟨	░	🟧	░	🟨	░	░	░	⬜	░	░	░	🟨
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E	Uvas/Llagas Creeks	Non-Retailer Area	░	░	░	⬜	░	░	░	🟨	░	░	░	⬜	░	░	░	⬜	░	░	░	🟨

Supported by Delivery Area **(DA)**	🟦
Supported by Groundwater Levels **(GL)**	🟧
Supported by Modeling **(M)**	🟩
Supported by Hydrogeologic Connectivity **(HC)**	🟨
Benefit Unconfirmed for Specific Activity- Overlapping **(GL)**	▦
Analysis Not Used to Define Zone Boundaries	░
Benefit Not Supported by Existing Information	⬜

GW = Retailer supplied by groundwater
TW = Retailer supplied by treated water

10.9 Economic Analysis

Table 13 shows the number of water supply wells in each of the proposed zones compared to the number of water supply wells in existing zones. Combining Table 10 and Table 13, along with association of all District activities with Zone W-2 and all but treated water deliveries and planned indirect potable reuse with Zone W-5, results in Table 14. Table 14 shows the number of water supply wells associated with each District activity for proposed zones compared to existing zones. This table will facilitate an economic analysis describing the change to revenue collection resulting from approving proposed zones. There is a decrease in the number of wells associated with each District activity except for treated water deliveries.

Table 13. Number of Water Supply Wells in Proposed Zones Versus Existing Zones

	Zone	Water Supply Wells By Zone	Total Water Supply Wells
Existing Zones	W-2	2,200	6,705
	W-5	4,505	
Proposed Zones	A	1,798	6,234
	B1	356	
	B2	68	
	C	559	
	D	3,156	
	E	297	

Table 14. Number of Water Supply Wells Associated with District Activities under Proposed Zones Versus Existing Zones

District Activity	Existing Zones	Proposed Zones	% Change
Managed Recharge (Local Runoff)	6,705	5,810	-13%
Managed Recharge (Imported Water)	6,705	5,513	-18%
Treated Water Deliveries	2,200	2,222	+1%
Recycled Water	6,705	4,954	-26%
Untreated Surface Water Deliveries	6,705	5,810	-13%
Conservation	6,705	6,234	-7%
Groundwater Protection	6,705	6,234	-7%
Planned Indirect Potable Reuse	2,200	1,798	-18%

11 FINALIZING GROUNDWATER BENEFIT ZONES

11.1 Administrative Issues

The Study recommends an increase in zones from two to six to associate zones with benefits from specific activities. However, the recommended zones are a result of a technical analysis that does not take into account the related administration issues or requirements for revised zones or increased number of zones. Any changes to the zones must be approved by the District Board of Directors, who will consider all related issues.

11.2 Metes and Bounds

The District needs the groundwater benefit zones to have a legal description in order to assess groundwater charges to groundwater users. Metes and bounds will provide this legal description.

In order to facilitate creation of the metes and bounds, Towill, Inc., the surveyor subcontractor on HydroMetrics WRI's consulting team, recommended taking steps to make changes to the zones to facilitate descriptions with metes and bounds. Since the proposed zones are based on geologic maps, the boundaries include many line segments that would each need to be described. In order to reduce requirements for metes and bounds descriptions, the boundaries have been simplified to reduce the number of line segments making up the boundaries. In addition to simplifying the boundaries, zone boundaries at geologic boundaries have been adjusted to account for available information on the uncertainty of those boundaries. As described in Appendix J, this approach involved a two-step process:

1. Simplify the boundaries based on mapped geology by applying a documented algorithm available in GIS software to reduce line segments with a specified distance tolerance.
2. Shift simplified boundaries a distance that accounts for uncertainty of geologic boundaries.

12 SUMMARY OF FUTURE PROCEDURES

12.1 Procedure for Well Exemption

Appendix K proposes a process for the District to evaluate requests to exempt or re-assign production wells from a groundwater benefit zone and, potentially exempt water produced from the well from all or part of a groundwater charge. The District Act requires the groundwater benefit zone to be modified if a well is found to be exempt.

This process includes the following general changes from the current process for evaluating requests for exemptions from the groundwater benefit zone, detailed in District Document No. SOP465-103 (SCVWD, 2011):

1. This process assesses exemption of wells from the groundwater benefit zone and potentially modifying the process to remove the well. The previous process provided a method for removing parcels from the groundwater benefit zone.
2. Instead of removing parcels from a groundwater benefit zone, an evaluation that a well should be exempt from a benefit zone will result in modification of the zone consistent with boundary simplification approach implemented for legal descriptions of the zones (Section 9.2).
3. The well may not be fully exempt from groundwater benefit zone, and may be re-assigned with a different that is associated with a different set of District activities.
4. Consistent with the Study, exemptions will be evaluated based on any relevant evidence not considered for the Study.
5. If exemption is approved to remove a well from the groundwater benefit zone, the zone will be modified based on best approximation of geology.

12.2 Procedure for Future Review

Appendix L presents a process for the District to conduct future reviews of the groundwater benefit zones.

Unlike the process for exemptions from a groundwater benefit zone, this process involves a comprehensive review of the boundaries of the groundwater benefit zones.

1. This process to review groundwater benefit zones does not occur in response to requests for exemption from a well owner. A separate process describes exemption or re-classification of individual wells from a benefit zone (Section 12.1).

2. Currently, reviews are only initiated at District staff's discretion, and upon receipt of new information. This new process requires a review of groundwater benefit zones if either of the following specified situations occur:
    a. Substantial changes to the type of District activities that provide the zone's benefits
    b. Significant new hydrogeologic data become available.

   Initiating review under these specified situations, the process helps ensures the groundwater benefit zones represent current District activities and the best available hydrogeologic information.

3. The review tasks differ based on the situation that initiates the review.

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14 ABBREVIATIONS

Alluvium	*Sediments primarily stream deposits of Quaternary age*
Cal Water	*California Water Service Company*
CGS	*California Geological Survey*
District	*Santa Clara Valley Water District*
DWR	*California Department of Water Resources*
GIS	*Geographic Information System*
GW	*Retailer area where groundwater supply is delivered*
Local SW	*Area receives San Jose Water Company surface water supply*
RWS	*Retailer area receives water from SFPUC Regional Water Supply System*
SBWRP	*South Bay Water Recycling Program*
SCRWA	*South County Regional Wastewater Authority*
SCVWD	*Santa Clara Valley Water District*
SFPUC	*San Francisco Public Utilities Commission*
SVAWPC	*Silicon Valley Advanced Water Purification Center*
Study	*Groundwater Benefit Zone Study*
TDS	*Total Dissolved Solids*
TW	*Retailer area receives SCVWD treated water deliveries*
USGS	*United States Geological Survey*

Appendix A

Methodology Memorandum

Methodology for Evaluating Groundwater Zones of Benefit Santa Clara County, California

Prepared for:
Santa Clara Valley Water District

August 2016

Prepared by:

HydroMetrics WRI

11570100.1

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EXECUTIVE SUMMARY

The Santa Clara Valley Water District (District) Act gives the District Board of Directors the authority to establish, amend, and revise groundwater charge zones and to levy and collect groundwater charges within a zone or zones that benefit from the recharge of underground water supplies or the distribution of imported water. The two primary existing charge zones, Zones W-2 and W-5, were established in 1963 and 1977, respectively. Zone W-2 generally covers the Santa Clara Plain in North County while Zone W-5 generally covers the Coyote Valley and Llagas Subbasin in South County

The purpose of the Groundwater Zone of Benefit Study (Study) is to complete a holistic review of the groundwater charge zones to ensure they reflect areas where current and future groundwater users receive similar benefit from current and planned District activities. Although the District is not aware of any specific problems with the existing Zone of Benefit designations, the District has received requests for exemption and recognizes that it is important for the District to periodically undertake an updated analysis of various factors upon which the zones are based and revise the boundaries if necessary. The Study will evaluate the ways in which the various District activities benefit groundwater users. These benefits are derived not only from the use of alternative water supplies for direct recharge, but also include the direct and indirect benefits of the District's holistic groundwater management, including in-lieu recharge, demand management, development of alternative water supplies and storage, conservation, and protection of water quality, amongst others.

An area within the District’s legal jurisdiction will be included in a groundwater zone of benefit if any of the following criteria are met:

- Water supply is provided by a District activity
- Groundwater supply reliability is improved due to District activities
- Land subsidence is prevented or limited due to District activities
- Saltwater intrusion is reversed or controlled due to District activities
- Groundwater quality is improved or maintained due to District activities
- Groundwater levels are improved due to District activities

Historical data and groundwater modeling will be used to assess the areas benefitting from District activities. If data and modeling are insufficient to assess whether an area benefits from District activities, the following assumptions will be made:

- Benefits from District activities extend to all areas that are hydrogeologically connected.

- Adjacent bedrock areas are not benefitting from District activities unless they are receiving District supply.

Evaluating groundwater zones of benefit is based on the hydrogeological characteristics that govern the movement of groundwater, District activities, and the benefits to groundwater users provided by the activities. The following methodology will be used to complete the study:

1. Map current and planned District activities that provide or will provide benefits to groundwater users in the District.
2. Map hydrogeologic features and groundwater occurrence and movement to define hydrogeologically connected areas.
3. Plot water balance over time in hydrogeologically connected areas to assess where the benefit of District activities can be demonstrated.
4. Use groundwater data and groundwater flow models to demonstrate the benefit of District activities.
5. Create recommended zones of benefit by grouping areas where users benefit from a similar set of District activities.

The evaluation of where groundwater users benefit from specific District activities will consider hydrogeologically connected areas and multiple lines of evidence. The lines of evidence can be grouped as follows:

1. Data demonstrating benefits derived from improved groundwater levels associated with District activities. In addition to groundwater level data, this includes the evaluation of land subsidence and saltwater intrusion data.
2. Groundwater model results demonstrating improved groundwater levels as a result of District activities have occurred or are projected to occur.
3. Data related to improved groundwater quality associated with District managed aquifer recharge.

All available information will be considered in identifying areas benefitting from specific District activities. Zones will be proposed for areas receiving benefits from similar sets of District activities.

INTRODUCTION

The Santa Clara Valley Water District (District) Act gives the District Board of Directors the authority to establish, amend, and revise groundwater charge zones and to levy and collect groundwater charges within a zone or zones that benefit from the recharge of underground water supplies or the distribution of imported water. The two primary existing charge zones, Zones W-2 and W-5, were established in 1963 and 1977, respectively. Zone W-2 generally covers the Santa Clara Plain in North County while Zone W-5 generally covers the Coyote Valley and Llagas Subbasin in South County (Figure 1). Figure 2 shows the three groundwater management areas of the District (Santa Clara Plain, Coyote Valley, and Llagas Subbasin) along with the California Department of Water Resources (DWR) subbasin definitions. Coyote Valley is part of southern zone W-5, but DWR includes Coyote Valley with the Santa Clara Subbasin in the north. While District water supply activities have changed considerably since the zones were established, the zones themselves have undergone only relatively minor, parcel-based revisions.

The purpose of the Groundwater Zone of Benefit Study (Study) is to complete a holistic review of the groundwater charge zones to ensure they reflect areas where current and future groundwater users receive similar benefit from current and planned District activities. The benefits to those who receive groundwater supplies are derived from the occurrence of groundwater and its movement through the sediments below ground surface. Therefore, the methodology will consist of hydrogeologic analyses consistent with existing understanding of the groundwater basins.

The Study will evaluate the ways in which the various District activities benefit groundwater users in different ways across the District. These benefits are derived not only from the use of alternative water supplies for direct recharge, but also include the direct and indirect benefits of the District's holistic groundwater management, including in-lieu recharge, demand management, development of alternative water supplies and storage, conservation, and protection of water quality, amongst others. Furthermore, due to the interconnected nature of the groundwater system, benefits are not limited to the immediate vicinity of particular District activities. Rather, benefits can extend from a project location throughout a surrounding basin or subbasin. Areas where groundwater users receive reasonably similar benefits or similar potential benefits from District activities, regardless of their surface proximity to District activities, will be grouped into zones. The purpose of this technical memorandum is to describe the approach and methodology for establishing the zones of benefit so that it can be reviewed and commented on by District partners and stakeholders.

As background for developing the methodology for this Study, HydroMetrics WRI conducted a cursory statewide review of other groundwater management agencies that have created multiple groundwater zones of benefit to determine the methodologies used to define the zones. A report summarizing the findings from that research is attached as Appendix A. The two significant findings are: 1) not many agencies who have the legal authorization to create groundwater zones of benefit have done so, meaning that the costs of groundwater management activities are spread throughout the agency's jurisdiction without making a distinction between benefits in different areas; 2) six agencies were identified that have developed a methodology for determining zone boundaries. Methods used by these six agencies to define zones of benefit vary between following DWR subbasin boundaries; identifying sub-areas based on hydrogeologic features; or creating a separate zone for areas benefitting from a singular beneficial activity such as delivered water. None of the agencies identified have undertaken the level of benefit analysis to justify the zone boundaries that will be performed in this Study.

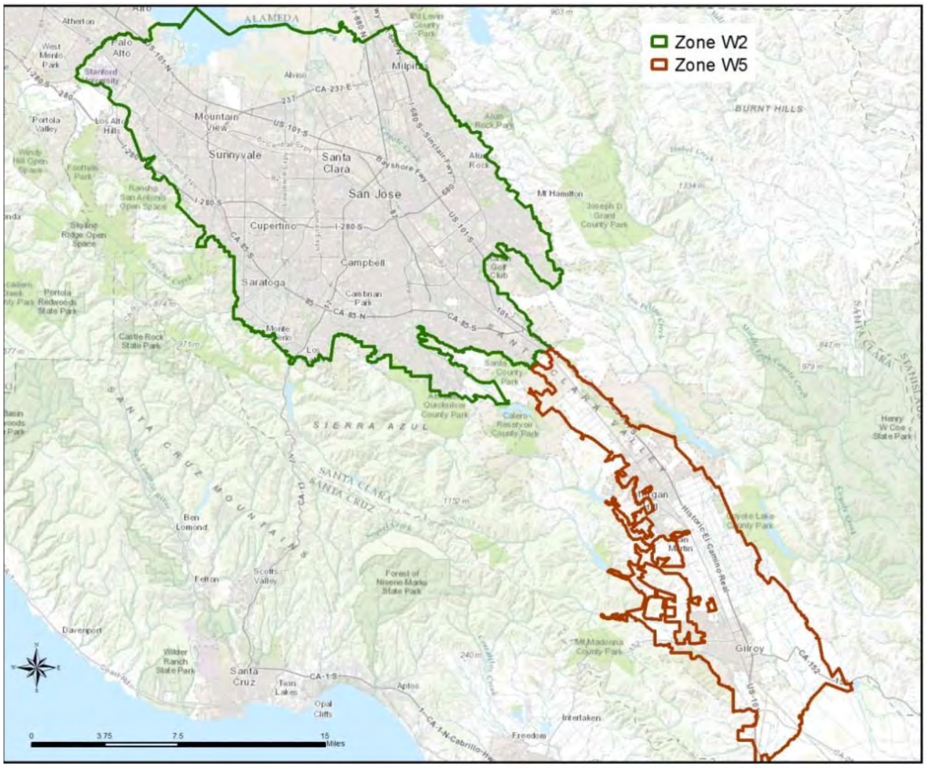


Figure 1: Existing Zones of Benefit

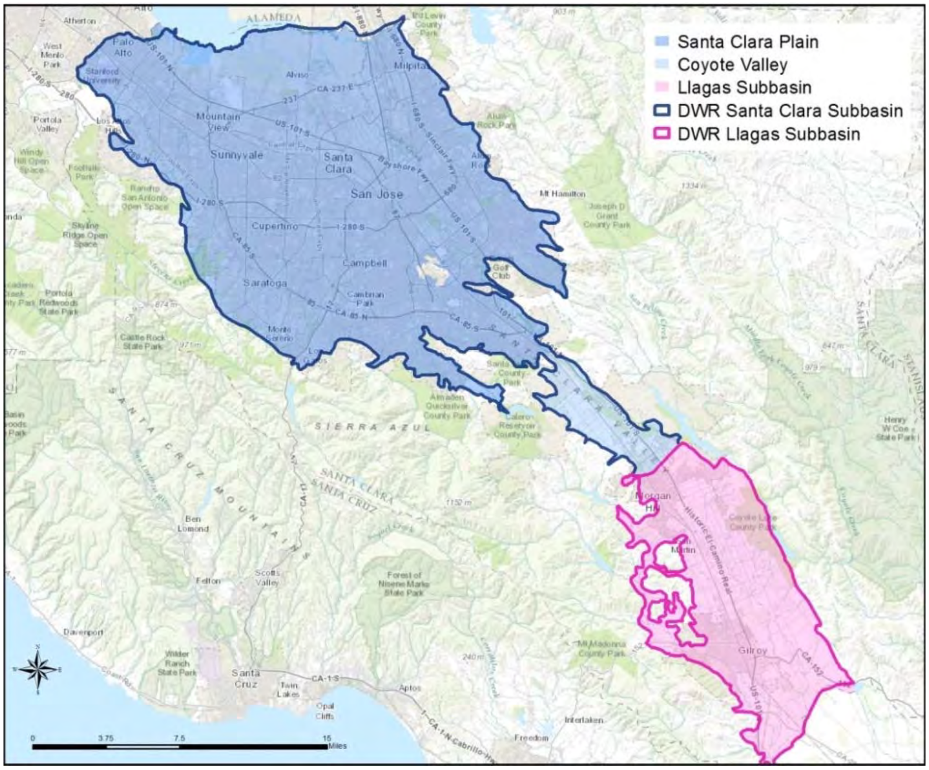


Figure 2: DWR Bulletin 118 Subbasins and District Groundwater Management Areas

CONCEPTS FOR EVALUATING GROUNDWATER ZONES OF BENEFIT

The proposed evaluation of groundwater zones of benefit is based on the hydrogeological characteristics that govern the movement of groundwater, District activities, and the benefits to groundwater users provided by the activities. First, we identify District activities that may provide benefits will be mapped. Second, we map hydrogeologically connected areas to the District activities. Third, we will map the areas where benefits to groundwater users from District activities are demonstrated. The recommended zones will be based on areas receiving benefit from similar District activities based on the analysis of hydrogeologically connected areas and observed and modeled groundwater data.

SUMMARY OF GROUNDWATER ZONE OF BENEFIT CRITERIA

An area within the District's legal jurisdiction will be included in a groundwater zone of benefit if any of the following criteria are met:

- Water supply is provided by a District activity
- Groundwater supply reliability is improved by District activities
- Land subsidence is prevented or limited due to District activities
- Saltwater intrusion is reversed or controlled due to District activities
- Groundwater quality is improved or maintained due to District activities
- Groundwater levels are improved due to District activities

Historical data and groundwater modeling will be used to assess the areas benefitting from District activities. If data and modeling are insufficient to assess whether an area benefits from District activities, the following assumptions will be made:

- Benefits from District activities extend to all areas that are hydrogeologically connected.
- Adjacent bedrock areas are not benefitting from District activities unless they are receiving District supply.

DISTRICT ACTIVITIES PROVIDING BENEFIT

District activities that provide a benefit to groundwater users include those covered under the District Act:

- Groundwater recharge,
- Importing water,
- Runoff capture,
- Water storage,
- Water treatment,

- Water distribution,
- Water recycling,
- Groundwater protection, and
- Water conservation.

The primary benefits to groundwater users are derived from District activities that support groundwater recharge. Managed aquifer recharge improves groundwater conditions by supplementing natural recharge of the underlying aquifers. Activities that support managed aquifer recharge are shown in
Figure 3. The District's direct delivery of water through various combinations of District activities, also shown in
Figure 3, improves groundwater conditions by reducing groundwater extractions; this is referred to as in-lieu recharge. Demand management through water conservation programs also constitutes in-lieu recharge.

Additional benefits are derived from the District's groundwater protection programs, which improve groundwater conditions by maintaining or improving groundwater quality. Protecting groundwater quality is inextricably linked to water supply reliability as are District efforts to conserve and augment groundwater supplies.

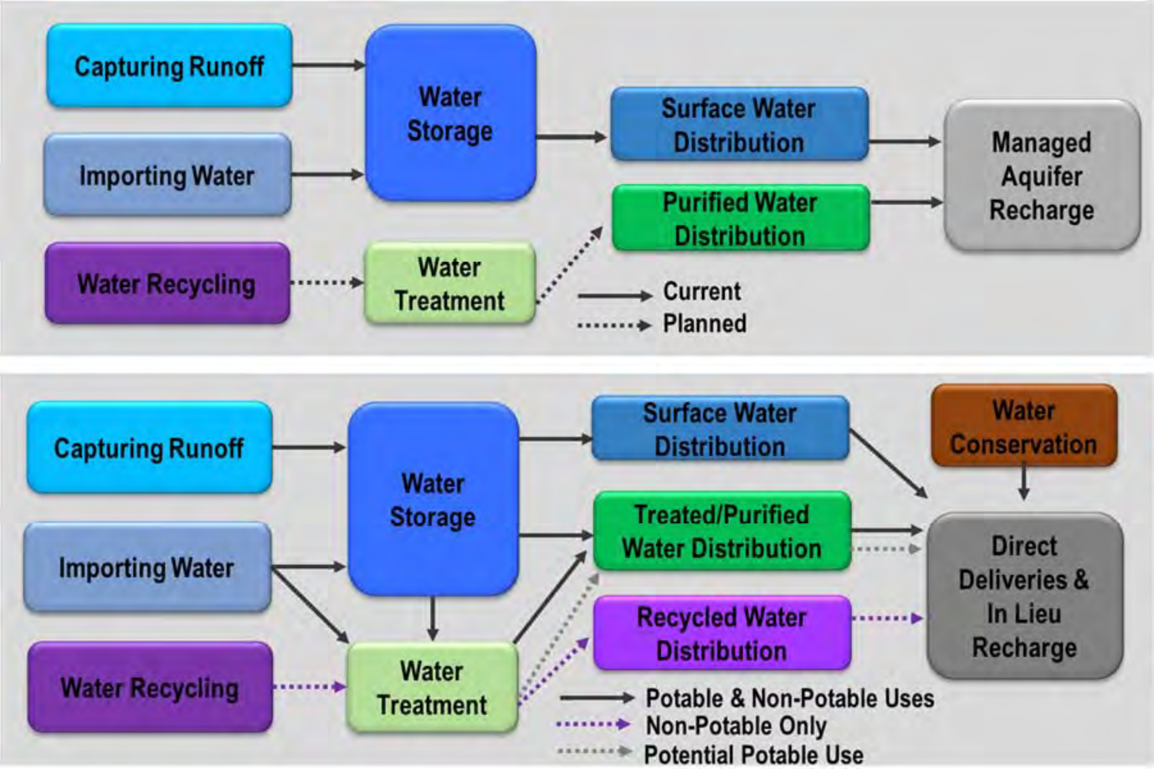


Figure 3: District Activities Supporting Groundwater Recharge For Benefit of Groundwater Users

BENEFITS OF DISTRICT GROUNDWATER MANAGEMENT ACTIVITIES

Groundwater is a shared resource that can be represented by a water budget, which includes estimates of groundwater inflows and outflows and conjunctive use of surface water supplies within a given area. Improved groundwater conditions resulting from District groundwater management activities can be summarized by an improved water budget, i.e. groundwater conditions would be worse in the absence of District activities. An improved water budget represents the overall benefit of District managed aquifer recharge and in-lieu recharge activities that sustain an area's groundwater supply. As an example, District activities in calendar year 2013 resulted in 96,000 acre-feet of managed aquifer recharge and 129,000 acre-feet of in-lieu recharge compared to 39,000 acre-feet of natural recharge (SCVWD, 2014). District activities that result in an improved water budget provide the following benefits to groundwater users:

Improved Groundwater Supply Reliability

On average, forty percent of the water used in Santa Clara County comes from wells pumping groundwater. Groundwater pumping (approximately 150,000 acre-feet in 2013) far exceeds natural recharge, and the District's managed and in-lieu recharge programs help replenish and sustain groundwater supplies. Figure 4 shows the rapidly growing population of Santa Clara County after World War II that was supported by a groundwater supply improved by District activities. This groundwater supply also supported high rates of business development and a viable agricultural economy. Community growth, quality of life and economic prosperity depend on a reliable and sustainable water supply that can be attributed to District groundwater management activities.

Reduced Risk of Land Subsidence

As shown in Figure 4, land in portions of the Santa Clara Valley subsided approximately 13 feet between 1915 and 1970 when groundwater pumping generally exceeded recharge. During that time, there was at least a 1-foot drop in the land surface over a 100-square mile area including portions of Palo Alto, Mountain View, Sunnyvale, Santa Clara, and San Jose. Since then, permanent subsidence has been halted due to an improved water budget resulting from District activities. Subsidence can result in adverse effects such as damaged infrastructure, increased flooding risk, increased sediment erosion or deposition, and, where relevant, impairment of leveled agricultural fields. Therefore, preventing subsidence is a benefit of the improved water budget resulting from District activities.

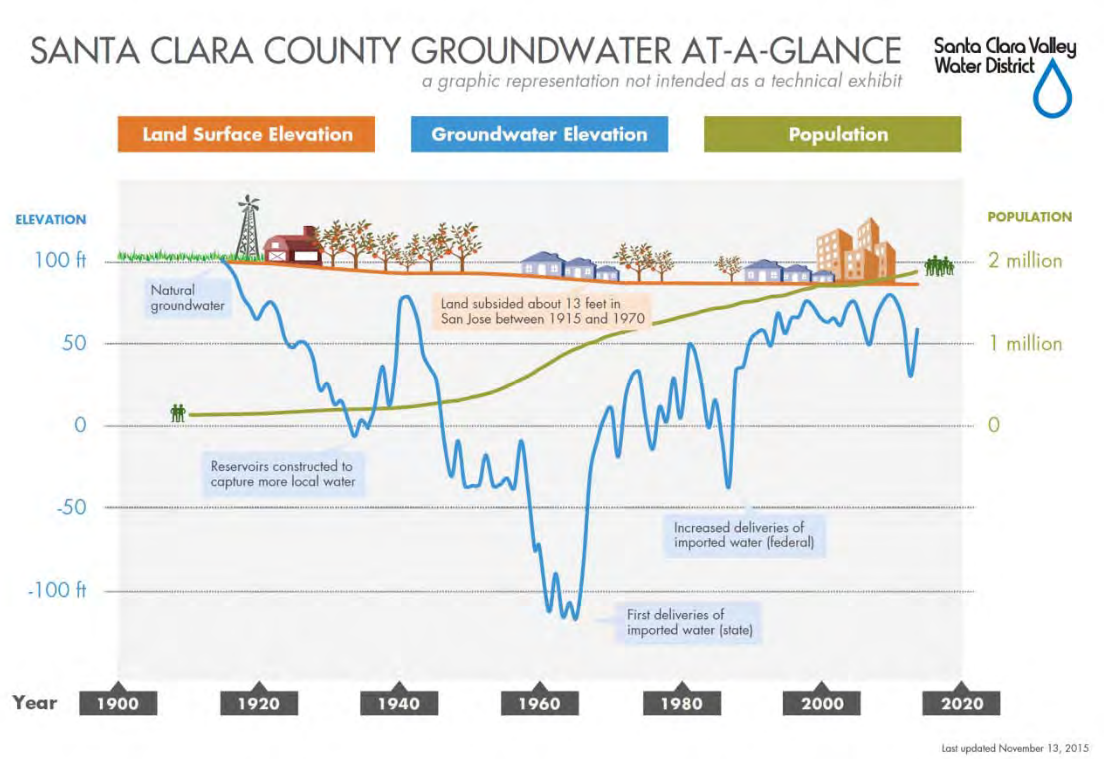


Figure 4: Graphic Representation of Groundwater Levels, Population and Land Subsidence (Courtesy SCVWD)

Saltwater Intrusion Prevention

Historically, denser saltwater moved inland from brackish channels connected to the San Francisco Bay when groundwater pumping exceeded natural recharge and subsidence resulted in greater tidal influence on the creeks connected to the bay. Figure 5 shows the inland migration of saltwater intrusion in the shallow aquifer zone from 1945 to 1980. Figure 5 additionally illustrates the reversal of saltwater intrusion in the shallow zone from 1980 to 2012. Saltwater intrusion adversely affects groundwater quality and can consequently have an adverse effect on groundwater use. Therefore, preventing saltwater intrusion is a benefit of the improved water budget from District activities.

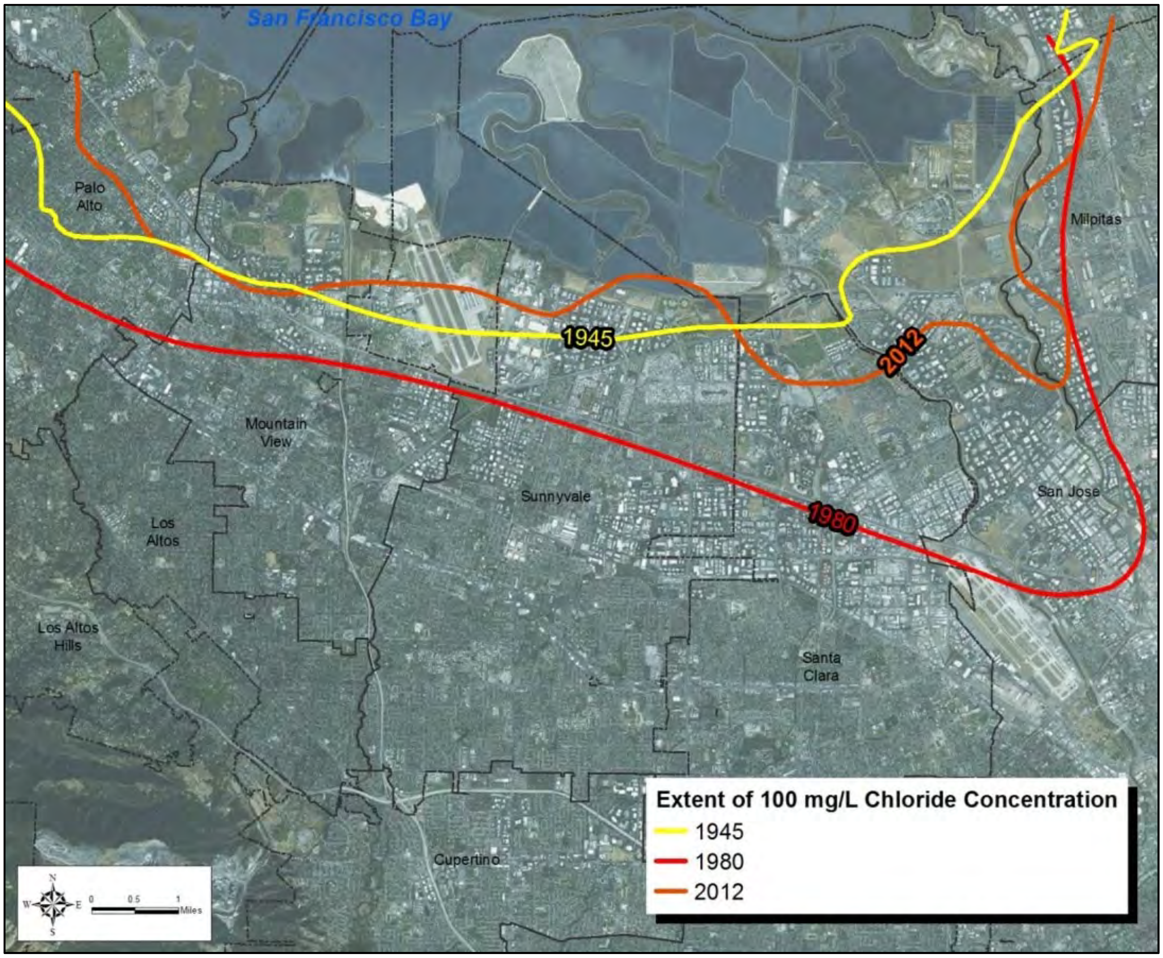


Figure 5. Extent of Shallow Zone Saltwater Intrusion

Improved Groundwater Quality

Recharge water can be higher quality than the ambient groundwater so an improved water budget from District activities can also improve groundwater quality. For example, nitrate concentrations are high in ambient groundwater in portions of the Llagas Subbasin, but imported water used for managed aquifer recharge has a dilution benefit by adding water with low nitrate concentrations to the water budget (MACTEC, 2009). Groundwater protection activities also conserve and improve groundwater quality. This prevents depletion of groundwater supply due to groundwater quality concerns and helps maintain an improved water budget.

MAPPING EXTENT OF BENEFITS BASED ON HYDROGEOLOGIC FEATURES

The initial evaluation of the areal extent of benefits from District activities will be based on defining hydrogeologically connected areas. District activities that improve the water budget are assumed to benefit all groundwater users within the hydrogeologically connected area subject to further evaluation with data and models described below. The areal extent of benefit beyond the District activity will be initially defined by mapping hydrogeologic features that control groundwater flow, such as the contact between water-bearing sediments and bedrock, the thickness of the water-bearing sediments, and the location of groundwater divides and faults. Mapping these features will form the boundaries of hydrogeologically connected areas that will be the first step for defining zones.

EVALUATING EXTENT OF BENEFITS WITH DATA AND MODELS

Field data, including groundwater levels, land subsidence, saltwater intrusion, and groundwater quality, will be evaluated to map the extent of benefits associated with District activities. Comparison of model simulations with and without District activities will also be used to map the extent of benefits. These maps will show areas where users receive benefits from a similar set of District activities. A defined zone of benefit will be created for each of these areas. There may be spatial data gaps, particularly along the subbasin margins, so areas demonstrated to be receiving benefit will be extended based on hydrogeologically connected areas as discussed above.

METHODOLOGY FOR EVALUATION OF GROUNDWATER ZONES OF BENEFIT

Groundwater zones of benefit will be defined initially based on areas of hydrogeologic connection and refined, if necessary, based on where benefits are demonstrated from a specific set of District activities. Groundwater flow extends benefits beyond the immediate location of activities to hydrogeologically connected areas. Benefits from current and planned District activities within initially defined hydrogeologic areas will be evaluated based on historical data and groundwater model results. The methodology to evaluate the zones of benefit will rely on a four-step process:

1. Map current and planned District activities that provide or will provide benefits to groundwater users in the District.
2. Map hydrogeologic features and groundwater occurrence and movement to define hydrogeologically connected areas.
3. Plot water balance over time in hydrogeologically connected areas to demonstrate overall benefit of District activities.

4. Use groundwater flow models and groundwater data to demonstrate the benefit of District activities.
5. Create recommended zones of benefit by grouping areas where users benefit from a similar set of District activities.

IDENTIFY AND MAP DISTRICT ACTIVITIES

As shown on
Figure 3, the two main categories of District activities that provide groundwater benefits are managed aquifer recharge and in-lieu recharge. The managed aquifer recharge facilities and end-point uses of deliveries that result in in-lieu recharge will be identified and mapped. The mapping of activities is illustrated on Figure 6 which contains a series of hypothetical maps for demonstrating the methodology.

Managed Aquifer Recharge Activities

Managed aquifer recharge occurs in District recharge ponds (off-stream recharge) and within streambeds (in-stream recharge). Geographic Information System (GIS) data of pond and stream features mapped by the District will be used to define these locations (Figure 6A). Benefits from managed aquifer recharge extend beyond the immediate area of recharge.

In order to evaluate the areal extent where groundwater users receive benefit from District managed aquifer recharge activities, recharge volumes will be plotted over time at each recharge system using data from the District. Recharge volumes over time represent changes in District activity that can be associated with groundwater benefits. When data or estimates for recharge volumes are not available for historical periods, periods when recharge volumes increased or decreased can be identified based on qualitative information such as commencement of recharge at any location.

In addition to identifying locations of current recharge from captured local runoff and imported surface water, potential locations of recharge from purified recycled water (Indirect Potable Reuse or IPR) will also be mapped. IPR is in the planning stage and is expected to be implemented by the District within the next 5 years.

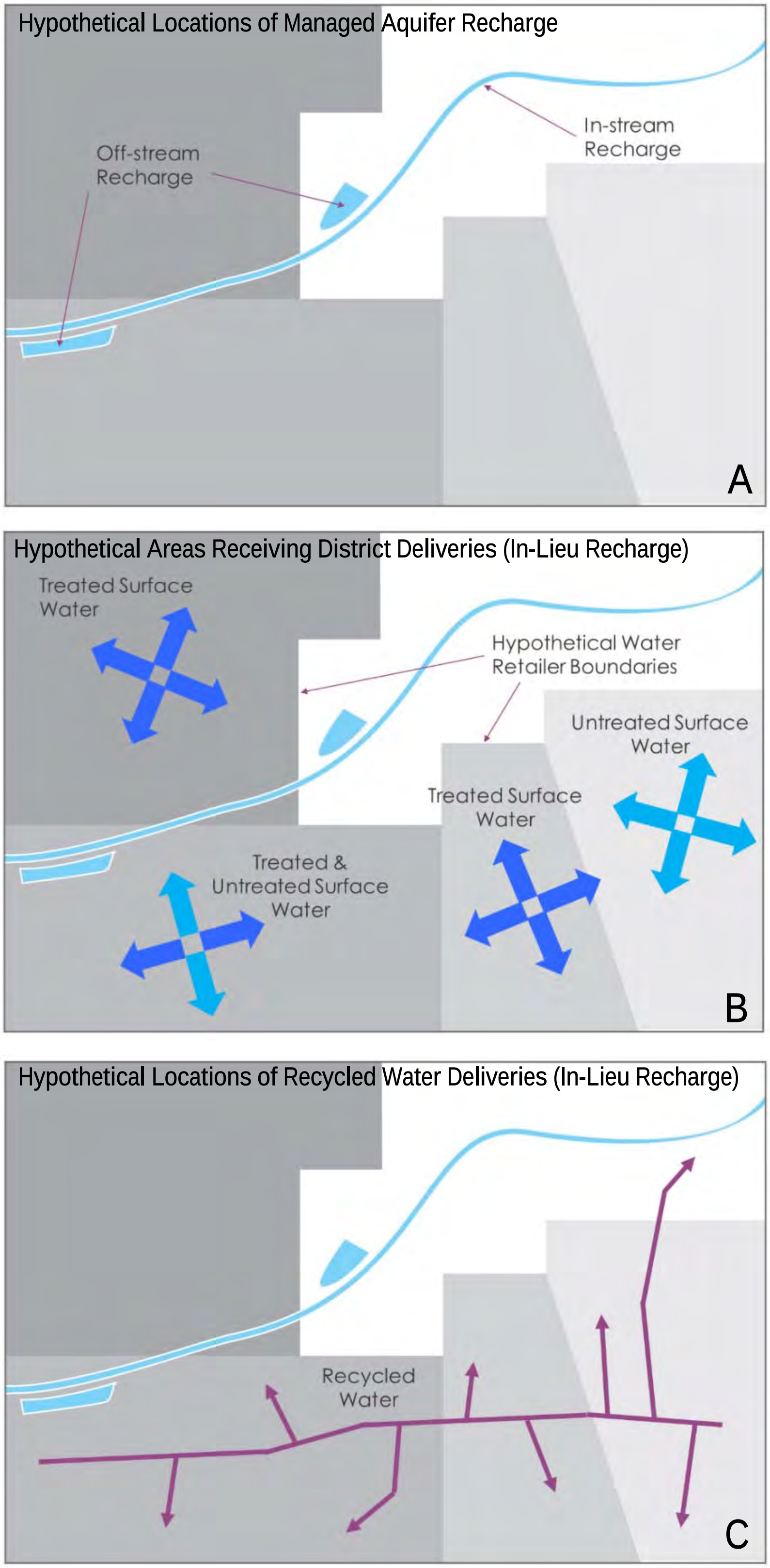

Hypothetical Locations of Managed Aquifer Recharge
Off-stream Recharge
In-stream Recharge
A
Hypothetical Areas Receiving District Deliveries (In-Lieu Recharge)
Treated Surface Water
Hypothetical Water Retailer Boundaries
Untreated Surface Water
Treated Surface Water
Treated & Untreated Surface Water
B
Hypothetical Locations of Recycled Water Deliveries (In-Lieu Recharge)
Recycled Water
C

Figure 6: District Activities Mapping Methodology

In-Lieu Recharge Activities

Deliveries of treated water that provide in-lieu recharge benefits to groundwater users will be mapped to correspond to the service area boundaries of the retailers that receive District water supplies (Figure 6B). If a retailer delivers specific District supplies to distinct areas, those distinct areas will be mapped. Deliveries of surface water to non-retailer users will also be mapped. More detailed mapping than retailer service areas will be required to distinguish areas within a retailer boundary that receive different water sources. For example, an area receiving raw surface water from the District would be distinguished from an area receiving treated surface water from the District. GIS data provided by the District, retailers, and California Public Utilities Commission (PUC) will be used to provide these boundaries. Groundwater users in the areas receiving deliveries of District treated, raw, and recycled water are benefitting from in-lieu recharge provided by the District supplies. In addition, benefits from in-lieu recharge also extend beyond the delivery area.

In order to identify areas where groundwater users benefit from District delivery of raw and treated surface water, the volumes of District water supplies over time to each area will be charted using data from the District. These volumes over time represent changes in District supplies that can be associated with groundwater benefits. When data or estimates for recharge volumes are not available for deliveries, periods when deliveries increased or decreased can be identified based on qualitative information such as the availability of imported water to deliver.

Areas receiving recycled water will also be mapped based on GIS data provided by the District (Figure 6C). As with surface water benefits, recycled water benefits extend beyond the areas of direct delivery. To evaluate the extent of the area receiving in-lieu benefits, as discussed below, deliveries of recycled water to various areas will be charted over time using data from the District.

Based on the availability of data, these charts may be limited to indicating when deliveries increased or decreased based on qualitative information about the recycled water program. Historically, the areas receiving recycled water have been smaller than areas receiving raw or treated surface water and the volumes of water were smaller, which may make it difficult to distinguish between in-lieu benefits from recycled water and raw and treated surface water. Therefore, areas receiving recycled water located within areas receiving raw or treated surface water will be grouped within the larger area receiving in-lieu benefits from raw or treated surface water deliveries. Areas receiving recycled water that are outside of areas receiving raw or treated surface water may provide in-lieu benefits that do not overlap areas with in-lieu benefits from raw or treated surface water deliveries.

Water conservation provides benefits to groundwater users resulting from in-lieu recharge facilitated by the reduced demand. These are broad benefits throughout the groundwater basins. Areas that benefit from managed aquifer recharge and other in-lieu recharge activities are also assumed to benefit from water conservation activities. However, to assist in identifying zones of benefit, areas where conservation activities occur will be mapped based on information from the District.

Groundwater Protection Activities

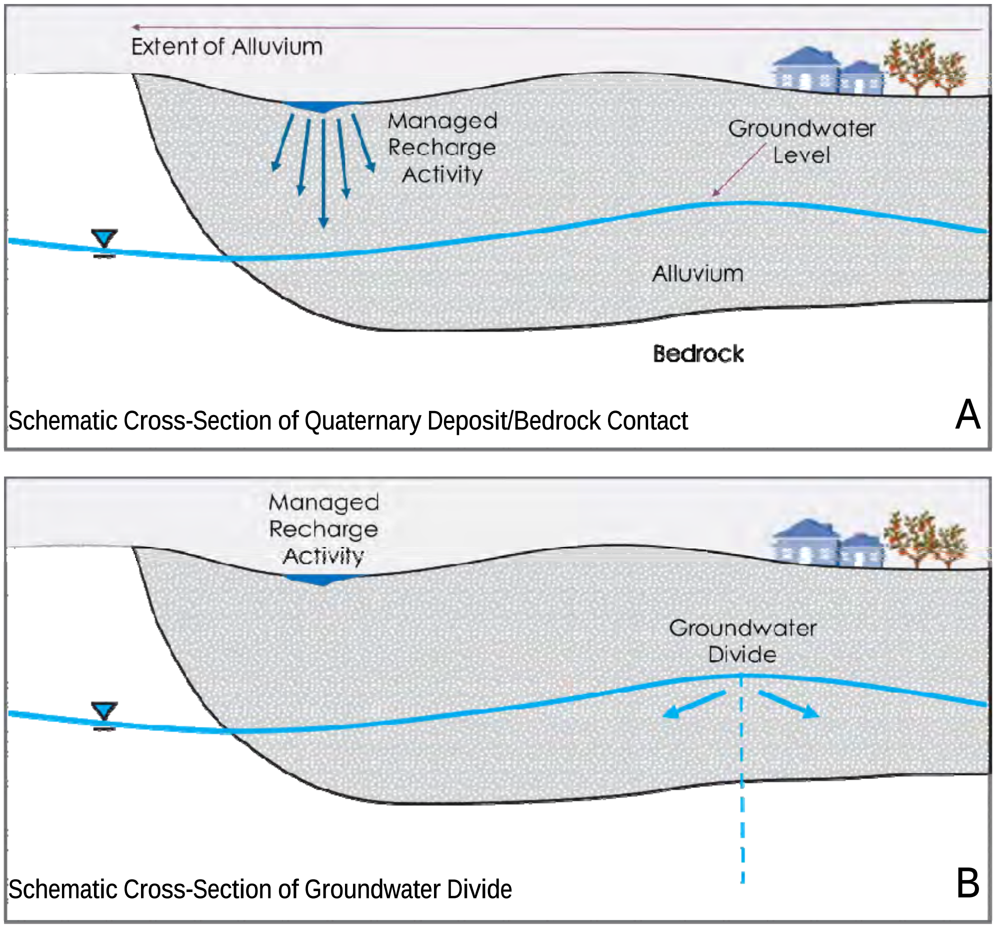
Groundwater protection activities provide broad benefits to groundwater quality throughout the groundwater basins. Areas that benefit from managed aquifer recharge and in-lieu recharge activities are also assumed to benefit from the groundwater protection activities. Similar to the approach to be used for water conservation activities, groundwater protection activities will be summarized and mapped based on information from the District to assist with identifying zones of benefit.

DEFINE HYDROGEOLOGICALLY CONNECTED AREAS BASED ON HYDROGEOLOGIC FEATURES

As discussed previously, District activities provide groundwater benefits beyond the immediate location of an activity. Groundwater flow patterns control how benefits extend beyond the activity locations. Several hydrogeologic features affect groundwater flow and will be mapped to define areas hydrogeologically connected to District activities. The planned features to be mapped are the contact between water-bearing sediments and bedrock and the location of groundwater divides and faults. These features will provide the boundaries for the hydrogeologically connected areas.

Mapping Water-Bearing Sediments

Quaternary deposits are mostly alluvium that provide the highest permeability for groundwater flow and therefore the greatest potential for connecting areas with groundwater users to benefits from District activities. Quaternary deposits mapped at the surface that are not specifically labeled alluvium are included because they are relatively young deposits and are relatively permeable compared to the older bedrock that bounds the basin. Bedrock has much lower overall permeability for groundwater flow and groundwater flow typically occurs in fractures that have not been mapped. Therefore, the Quaternary deposit/bedrock contact (Figure 7A) will define the hydrogeologically connected areas used to define the extent of potential benefit.



Schematic Cross-Section of Quaternary Deposit/Bedrock Contact

Schematic Cross-Section of Groundwater Divide

Figure 7: Schematic Cross-Sections

The Quaternary deposit/bedrock contact will be based on existing sources, such as mapping by the U.S. Geological Survey and California Geological Survey, including but not limited to *Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California* (Witter et al., 2006) and *Preliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine County San Francisco Bay Region, California* (Knudsen et al., 2000). GIS formats of these maps are available for use in this study.

Available basin wide information on the thickness of the Quaternary deposits and stratigraphy of the deposits will also be mapped. Large changes in thickness or stratigraphy could be geologic features that affect how groundwater flows between areas. One source that will be considered is *Physical Subdivision and Water-Bearing Sediments of the Santa Clara Valley, California* (Wentworth et al., 2015). These maps only cover North County.

Groundwater Divides and Faults

A groundwater divide occurs where there is a regionally high groundwater level and groundwater flows in opposite directions on either side of the divide (Figure 7B). Groundwater benefits are unlikely to extend from a District activity on one side of the divide to the other side of the divide unless the activity provides a large enough change to groundwater levels or is close enough to the divide to actually alter the divide's location. Groundwater divides can change over time, so groundwater divides over different years will be mapped to the extent possible. Available District groundwater level contour maps will be evaluated to identify the groundwater level contours that represent a divide. One of the main groundwater divides of interest is expected to be in South County between the Coyote Valley and Llagas Subbasin. California Department of Water Resources defines the northern boundary of the Llagas Subbasin based on the groundwater divide near Cochrane Road in Morgan Hill (DWR, 2004).

Faults can be barriers to groundwater flow. However, faults are not expected to be significant barriers to flow that define the extent of benefits in the District. Nonetheless, faults will be mapped and groundwater flow in the vicinity of faults will be evaluated . The initial evaluation will compare mapped faults with the contour maps. Faults identified as barriers to groundwater flow will be considered when identifying areas with improved groundwater levels as discussed below. The U.S. Geological Survey and California Geological Survey (2010) have developed fault maps in GIS format, which will be used for this purpose.

PLOT WATER BUDGET OVER TIME IN HYDROGEOLOGICALLY CONNECTED AREAS

In order to summarize the benefit of District activities in hydrogeologically connected areas, the water budget in each area will be plotted over time. The plots will show the effect of District activities on the water budget for the hydrogeologically connected area. Estimated volumes for different categories of District activities shown in Figure 3 that result in managed aquifer and in-lieu recharge will be included along with estimates of outflows such as pumping. There may not be data or published estimates for volumes of groundwater inflows and outflows for historical periods, but the plots will represent and document the conceptual water budget for these periods given available information. These plots will provide background for how District activities improve conditions for the shared groundwater resource defined by each hydrogeologically connected area.

EVALUATE AREAS WHERE GROUNDWATER USERS BENEFIT FROM SPECIFIC DISTRICT ACTIVITIES

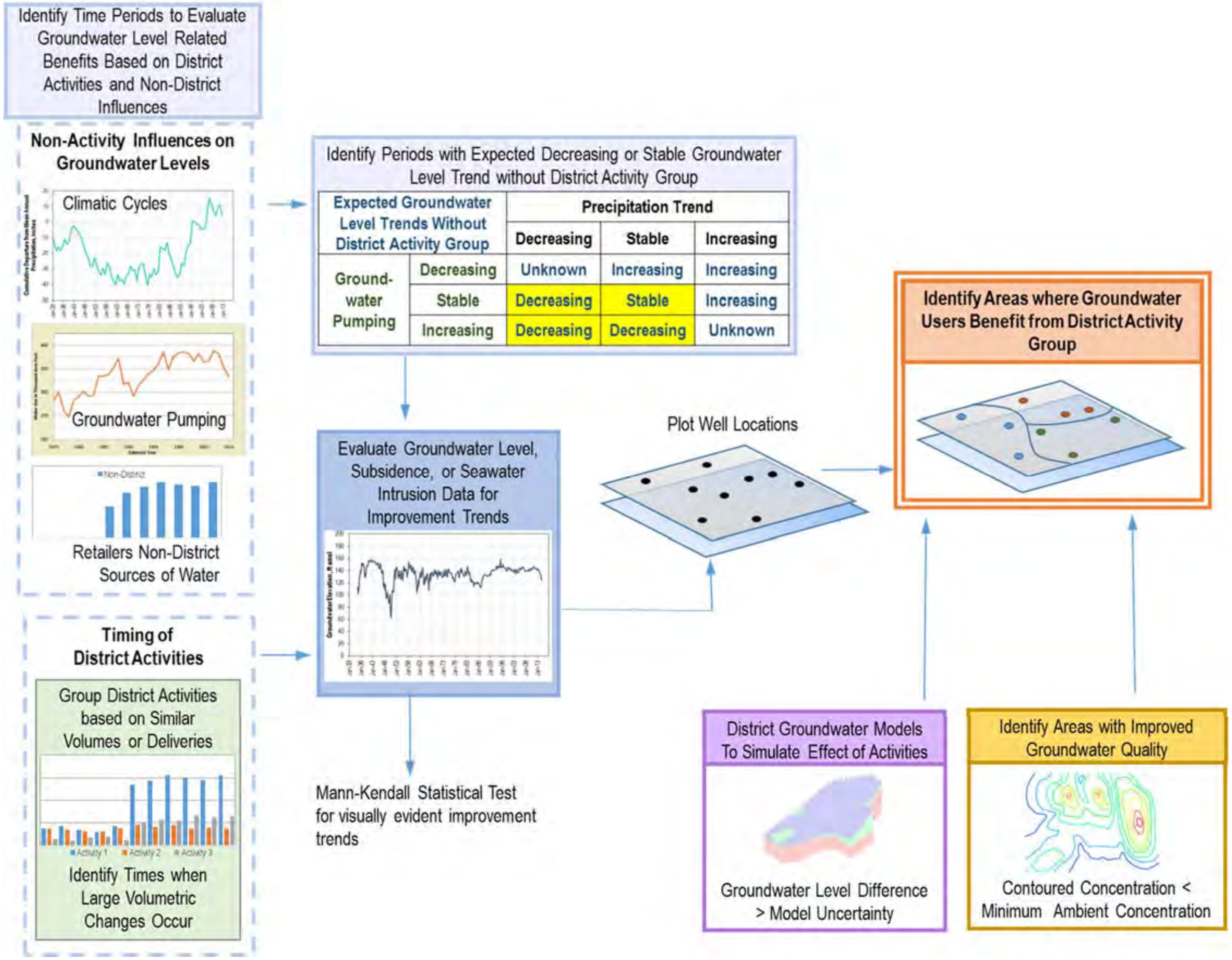
The evaluation of where groundwater users benefit from specific District activities will consider multiple lines of evidence. The lines of evidence can be grouped as follows:

1. Data demonstrating benefits derived from improved groundwater levels associated with District activities. In addition to groundwater level data, this includes the evaluation of land subsidence and saltwater intrusion data.
2. Groundwater model results demonstrating improved groundwater levels as a result of current or future District activities.
3. Data demonstrating improved groundwater quality associated with District managed aquifer recharge.

All available information from these lines of evidence will be considered in identifying areas benefitting from specific District activities. Figure 8 summarizes the use of the three lines of evidence. If any of the lines of evidence demonstrate that groundwater users in an area benefit from a set of District activities, then the area will be mapped as benefitting from that set of District activities. Additional lines of evidence and alternate methods of evaluating information may be considered as new information become available and data are compiled. Any changes to methodology will be fully documented.

Evaluation of Data Related to Improved Groundwater Levels

This line of evidence is based on an evaluation of groundwater levels, land subsidence, and saltwater intrusion data. If data show groundwater levels, land subsidence, and saltwater intrusion in an area have improved or stabilized as a result of a District activity, then groundwater users in the area are benefitting from that activity. Historically, the District has implemented its activities to mitigate chronic overdraft that was causing undesirable effects such as declining groundwater levels, subsidence and saltwater intrusion. Therefore, the analyses will find a beneficial improvement whenever District activities result in any rise or stabilization of groundwater levels or prevention of the undesirable effects associated with declining groundwater levels. These groundwater level analyses are summarized in Figure 8 and described in greater detail below. The analysis as applied to groundwater level data is described immediately below. Discussion of specific differences in the analyses of land subsidence and saltwater intrusion data from the evaluation of groundwater level data follows.


Identify Time Periods to Evaluate Groundwater Level Related Benefits Based on District Activities and Non-District Influences
Non-Activity Influences on Groundwater Levels
Climatic Cycles
Groundwater Pumping
Non-District
Retailers Non-District Sources of Water
Timing of District Activities
Group District Activities based on Similar Volumes or Deliveries
Activity 1
Activity 2
Activity 3
Identify Times when Large Volumetric Changes Occur
Identify Periods with Expected Decreasing or Stable Groundwater Level Trend without District Activity Group
Evaluate Groundwater Level, Subsidence, or Seawater Intrusion Data for Improvement Trends
Mann-Kendall Statistical Test for visually evident improvement trends
Plot Well Locations
Identify Areas where Groundwater Users Benefit from District Activity Group
District Groundwater Models To Simulate Effect of Activities
Groundwater Level Difference > Model Uncertainty
Identify Areas with Improved Groundwater Quality
Contoured Concentration < Minimum Ambient Concentration

Expected Groundwater Level Trends Without District Activity Group		Precipitation Trend		
		Decreasing	Stable	Increasing
Groundwater Pumping	Decreasing	Unknown	Increasing	Increasing
	Stable	Decreasing	Stable	Increasing
	Increasing	Decreasing	Decreasing	Unknown

Figure 8. Flow Chart for Identifying Areas where Groundwater Users Benefit from Improved Groundwater Conditions

Analysis Applied to Groundwater Level Data

Groundwater level improvements associated with District activities will first be evaluated based on trends in groundwater level observation data at wells throughout the District. As described above, there are two main categories of District activities providing groundwater level improvement benefits: managed recharge and in-lieu recharge. In-lieu recharge encompasses a number of types of activities providing in-lieu recharge: treated water delivery, untreated surface water delivery, recycled water delivery, and conservation. The purpose of this analysis is to identify groundwater level improvements associated with specific groups of District activities. The steps for this analysis will be as follows:

1. Group District activities based on category, type, location and similar volumetric recharge or deliveries over time. This grouping will be based on the most reliable information available.
2. Identify time periods when volumetric recharge or deliveries increase for each group of activities from step #1. As in step #1, time periods will be identified based on the most reliable information available.
3. In order to evaluate the influence of each group of District activities on groundwater levels, evaluate influences on groundwater levels (as described below) that are unrelated to the group of District activities being evaluated (hereafter also referred to as "the District activity group") over each time period identified for the District activity group in step #2. These influences may be hydrologic conditions, non-District activities, or other District activities[1] not in the District activity group. Based on the evaluation of these influences, identify whether the expected groundwater level trend without the District activity group would be decreasing, stable, or increasing over each time period.
4. If the expected groundwater level trend without the District activity group , as defined in step #3, is decreasing or stable, evaluate whether the groundwater level trend in wells throughout the District show an improvement compared to the expected trend over the identified time period. Although periods will not be evaluated when there is an expected increasing groundwater level trend even

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[1] Evaluating influences from other District activities has been added to the methodology since draft methodology was shared with stakeholders. This will facilitate evaluating benefits from District managed recharge in areas that receive District in-lieu recharge supplies. As a result, we are evaluating groundwater pumping for an area instead of non-District net demand as described in draft methodology.

without the District activity group , any demonstrated benefit from District activities for the area would still occur during those periods.

When volumetric recharge or deliveries increase over time from a District activity group (steps #1 and #2), groundwater levels should improve or stabilize in the areas with groundwater users receiving a benefit from the District activity. Time periods of increasing volumes will typically be associated with a new source of water coming online. The groundwater level trend at wells will be evaluated over each time period with increased volumes to assess whether an area's groundwater users are receiving a benefit from the District activity.

The evaluation of hydrographs will also consider other influences on groundwater levels over the time periods identified in steps #1 and #2 that are unrelated to the District activity group, such as changing climatic cycles, water demand, and water suppliers' sources of water. The effect of these other influences on the water balance will be evaluated to identify the expected groundwater level trend without the District activity (step #3).

Changing climatic cycles will be represented by charting the departure of mean annual precipitation from the mean precipitation measured at the nearest gauge with valid data. Historic long-term precipitation data from the ALERT hydrologic data collection system within or close to the groundwater basins will be used. The data from the most-representative station or stations for an area will be used for evaluating the climatic cycle. Figure 9 shows an example mean annual precipitation departure curve with periods of different precipitation trends. If groundwater levels responded only to climatic change, the expected groundwater level trend would be decreasing between 1942 and 1955 based on the decreasing precipitation trend. The expected groundwater level trend would be increasing between 1992 and 2005 based on the increasing precipitation trend. Although any benefit from a District activity would still be occurring, we will not be able to distinguish a groundwater benefit from District activities based on increasing groundwater levels during a period of increasing precipitation.

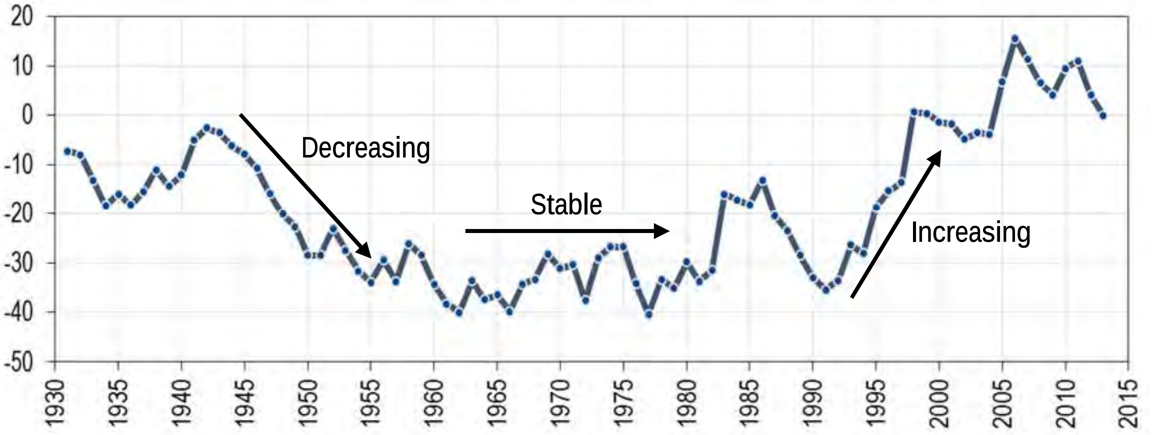

Figure 9: Example of Cumulative Departure from Mean Annual Precipitation

There are instances where water suppliers provide water sources other than groundwater, which for this study is referred to as in-lieu water supply. Groundwater pumping represents the expected influence of each water supplier's in-lieu water supplies on groundwater levels. In-lieu water supplies reduce groundwater pumping, and groundwater pumping has an inverse relationship to expected groundwater trends. Groundwater pumping will be evaluated for each water supplier's service area receiving a specific set of in-lieu water supplies. We expect a trend of decreasing groundwater levels when groundwater pumping increases within a water supplier's service area. We expect a trend of increasing groundwater levels when groundwater pumping decreases within a water supplier's service area.[2] This evaluation identifies periods when benefits from either a managed recharge or in-lieu District activity group cannot be identified due to non-District in-lieu water supplies. This evaluation also identifies periods when benefits from a managed recharge District activity group cannot be distinguished from District in-lieu recharge activities. In either of these cases, those periods will not be evaluated.

During periods of decreasing groundwater pumping, water budget information will be evaluated to assess whether the District's conservation activities may have resulted in decreasing groundwater pumping. If so, increasing groundwater levels during such a period would further demonstrate benefit from District conservation activities, but would be unable to demonstrate benefit from the District's other recharge activities.

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[2] In order to account for non-District in-lieu recharge activities, groundwater pumping is equivalent to non-District net demand concept discussed in draft methodology shared with stakeholders.

Land use changes can also alter water demand. The study will include a high level description of land use changes that have impacted demand, and such changes will not be attributed to District activities.

Table 1 shows the nine potential combinations of precipitation trends and groundwater pumping trends and the expected groundwater level trends without the District activity group based on those combinations. In order to identify groundwater benefits from District activities other than conservation, groundwater level trends will be evaluated when the expected trend is stable or decreasing. The four expected scenarios that result in stable or decreasing groundwater level trends are shown in grey boxes on Table 1. These expected groundwater level trends can be compared to observed groundwater level trends to identify benefits from District activities.

Based on this analysis, a benefit from the District activity group will be demonstrated when:

- the expected groundwater level trend without the District activity group is decreasing and observed groundwater level trends are stable or increasing
- the expected groundwater level trend without the District activity group is stable and the observed groundwater level trend is increasing

If the expected groundwater level trend without the District activity group is unknown or increasing, there will not be enough information to determine the benefits from District activities. However, a benefit from the District activity group as demonstrated during other periods would still occur during these periods.

Table 1: Expected Groundwater Level Trend Based on Precipitation and Groundwater Pumping (Without the District Activity Group)

Expected Groundwater Level Trend Without the District Activity Group		**Precipitation Trend**		
		Decreasing	**Stable**	**Increasing**
Groundwater Pumping	**Decreasing**	Unknown	Increasing	Increasing
	Stable	Decreasing	Stable	Increasing
	Increasing	Decreasing	Decreasing	Unknown

Groundwater level hydrographs will be evaluated for a trend that demonstrates a groundwater level improvement compared to the expected trend and therefore a benefit to groundwater users in the area from the District activity (step #4). The groundwater level trend demonstrating improvement will need to be visually evident in the hydrograph over the period of increased volumes by the District activity as identified in step #2. A single period that shows groundwater level improvement from the District activity demonstrates benefit to groundwater users in the area because the benefits may be masked for periods where other influences evaluated in step #3 prevent identification of improvements from District activities. Figure 10 shows an example hydrograph with periods of increased volumes by District activities annotated based on new water sources being secured by the District. Note that the increasing trend in the late 1930s would likely not be used to demonstrate benefit based on groundwater level data because precipitation increased during that time (Figure 9) while the stable trend in the 1950s would be used to demonstrate benefit because precipitation was stable and demand increased.

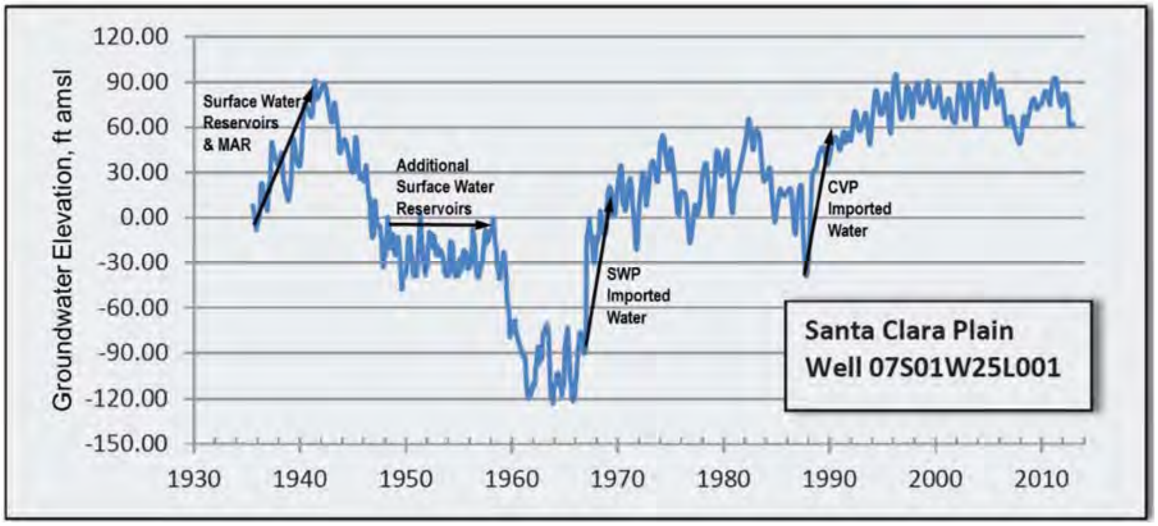

Figure 10: Groundwater Level Responses to District Activities

In order to quantify the statistical significance of the visually evident groundwater level trend demonstrating improvement, a Mann-Kendall test will be performed for data over the time period when a trend demonstrates improvement. The Mann-Kendall test is appropriate because it is non-parametric and does not rely on the distribution of the data set (Heisel and Hirsch, 2002). If data show regular seasonal variation, the seasonal Kendall test will be performed to calculate the probability that the visually evident trend is false.

If groundwater level data from a well demonstrates a benefit from a set of District activities for any time period, the map of benefits to groundwater users from that set of District activities will extend to the hydrogeologically connected area around the well.

Data used for the hydrograph analyses will be from the District's monitoring well network, and from water suppliers and stakeholders, as available. Data being considered for use will be evaluated to verify adequate measurement protocol and ensure there are sufficient regularly measured static groundwater levels to evaluate trends during times of increased volumes from District activity (step #2). Stakeholders should submit all information about the well such as a well log and construction information.

Available data for individual wells will be evaluated to ensure the wells are representative of aquifer conditions. Criteria that will be used to evaluate which individual wells will be used in the analysis include, but are not limited to:

- Well construction information, such as well depth, screened intervals, and lithology
- Period/frequency of water level measurements
- Completeness of water level records

Stakeholders are also encouraged to provide any other information, including data related to the calculation of groundwater pumping and non-District recharge activities, that they wish the study to consider. For example, information about non-District recharge activities would be evaluated using a similar procedure to District managed recharge activities. Hydrographs for wells near a non-District recharge activity would be compared to the non-District recharge quantities over time as well as District activity quantities over time to assess whether groundwater level improvements at those wells can be associated with District activities and are not solely a result of the non-District recharge activity.

Analysis of Land Subsidence Data

Improved groundwater levels are the mechanism by which land subsidence has been halted and prevented. However, land subsidence data will also be useful for evaluating benefit from District activities to groundwater users. Subsidence data will be evaluated from locations where land subsidence has occurred since 1915. Data to be evaluated includes key benchmark ground surface elevations and extensometer measurements. The expected trend without District activities given the historical subsidence at the location is continued lowering of the ground surface. If data show subsidence stops occurring after groundwater volumes increase from a set of District activities, a benefit to groundwater users in the area is demonstrated.

Analysis of Saltwater Intrusion Data

Similar to land subsidence, improved groundwater levels are the mechanism by which saltwater intrusion has been halted or reversed. Likewise, saltwater intrusion data will also be useful for evaluating benefit from District activities to groundwater users. Saltwater intrusion data represented by chloride concentrations will be evaluated from wells along the San Francisco Bay where concentrations increased above 100 mg/L after 1945. The trend in chloride concentrations over and after periods of increased water volumes from District activities will be evaluated using similar methodology to trends in groundwater levels. Trends at monitoring locations may not follow the same time periods because the effect of improved groundwater levels on saltwater intrusion may be delayed. The expected trend without District activities given the historical saltwater intrusion at the location is continued saltwater intrusion or increasing chloride concentrations. If chloride concentration data show a trend of stable or decreasing concentrations after groundwater volumes increase from a set of District activities, a benefit to groundwater users in the area is demonstrated.

Groundwater Model Simulations

Results from groundwater model simulations will be a second and equivalent line of evidence evaluated for the effect of District activities in different areas. The simulated data will be generated using calibrated District groundwater flow models for the Santa Clara Plain, Coyote Valley, and Llagas Subbasin.

Evaluating whether groundwater levels improve from District activities will be performed by comparing simulations of conditions with and without District activities. Therefore, the modeling will evaluate the same sets of District activities evaluated in the groundwater level analysis.

District activities for managed aquifer recharge are simulated in various ways in the models and reduced recharge volumes will simulated accordingly. Reduced volumes of deliveries for in-lieu recharge will be simulated as increased pumping in the models. Complete removal of managed aquifer recharge and/or delivered water for any set of District activities may alter the water balance so drastically that the basin completely dries out in the model so alternatives such as partial reductions in recharge volumes may be used for the model to provide meaningful results that can be used to evaluate the effect of District activities.

Groundwater levels simulated with District activities removed or reduced will be subtracted from groundwater levels simulated with actual historical conditions. The average difference in groundwater levels will be calculated over the modeled time period of the set of District activities. The map of the average differences will show where groundwater levels improve and benefits occur. All models have some uncertainty, and we will ensure that the benefits we identify in the model are the result of District activities, and not model uncertainty.

If results from model simulations using the Santa Clara model evaluating indirect potable reuse are available, results showing benefit from the planned recharge of purified water will be used in the evaluation.

Identifying Areas with Improved Groundwater Quality

The first step in identifying areas with improved groundwater quality as a result of District activities is identifying key constituents that differentiate ambient groundwater from recharge water. Possible constituents include total dissolved solids and nitrates. For each of these constituents, the expected range of concentrations will be estimated for ambient groundwater and recharge water. Contours of current groundwater quality will be developed around recharge streams and ponds for identified constituents using data from monitoring wells sampled by the District. Contours of concentrations below the low end of concentrations expected for ambient groundwater will define the area with improved groundwater quality and therefore benefits from the managed aquifer recharge. Isotopic analysis that differentiate ambient groundwater from recharge water will also be considered. These data were collected by the GAMA program (Ray, 2009) and as part of the Olin remediation project (MACTEC, 2009).

PROPOSING ZONES OF BENEFIT

Zones of benefit will be proposed based on the analyses described above that provides maps illustrating where groundwater users are benefiting from District activities. Zones will be proposed for areas receiving benefits from similar sets of District activities.

SUMMARY

District activities provide benefits to groundwater users through managed aquifer recharge, in-lieu recharge, and groundwater protection. A methodology has been outlined that defines the areas hydrogeologically connected to District activities. Then, available data and groundwater model simulations will be evaluated to identify the benefits from all District activities in the area. Zones of benefit will be defined based on areas receiving benefits from similar sets of District activities.

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APPENDIX A: EVALUATION OF METHODOLOGIES USED TO ESTABLISH GROUNDWATER ZONES OF BENEFIT IN CALIFORNIA

Historically, California water agencies have been limited in their ability to establish groundwater zones of benefit as a means for funding projects and programs. Statutes creating agencies to manage groundwater (such as the Santa Clara Valley Water District Act) as well as other special act districts providing water related services (e.g. Coachella Valley Water District, Monterey County Water Resources Agency, and San Benito County Water District) have various provisions related to creating charge zones. Water conservation districts formed under Water Code Division 21, and agencies providing groundwater management under AB3030 (Water Code Sections 10754 *et. seq.)* are legislatively authorized to form zones of benefit and assess charges to groundwater users to recover the cost of district activities that benefit the groundwater resource. At the request of Santa Clara Valley Water District, HydroMetrics WRI has researched current groundwater zones of benefit and the methodologies used to establish multiple zones within a single agency's jurisdiction.

The initial agencies to review for methodologies establishing groundwater zones of benefit were identified from a paper on funding sustainable groundwater management in California posted by the UC Davis Center for Watershed Sciences (Hanak et al., 2014). The UC Davis paper includes a chart prepared by the Public Policy Institute of California listing groundwater pumping charges in special act districts as of 2013/2014. Of the 15 agencies created by statute to manage groundwater, the authors found evidence that only five of those agencies charge pumping fees, including Santa Clara Valley Water District[3]. Of the remaining four, only Pajaro Valley Water Management Agency assesses charges depending on pumping location, thereby establishing different charge zones. The paper also notes that, according to the DWR Bulletin 118 2003 update, none of the AB 3030 agencies was known to have exercised its authority to enact groundwater pumping charges through the creation of groundwater replenishment districts. Five additional agencies with multiple charge zones were identified through personal knowledge and research. These are the special act districts of Coachella Valley Water District, Monterey County Water Resources Agency (Salinas Valley Basin), and San Benito County Water District, and the water conservation districts of Santa Ynez

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[3] It is worth noting that the activities performed by these agencies to manage groundwater range considerably. In previous research, HydroMetrics WRI could not find any evidence that four of the listed agencies are functioning and three others do not appear to have active groundwater restoration programs.

River Water Conservation District and United Water Conservation District. The methodologies used by the six identified agencies to establish multiple zones of benefit are summarized below.

COACHELLA VALLEY WATER DISTRICT (CVWD)

The CVWD has three zones of benefit. Initially, there were two zones with boundaries corresponding to DWR subbasins. A USGS study indicated a clay aquitard within the Whitewater River subbasin, which resulted in CVWD sub-dividing that zone of benefit into two. No further analysis of the zone boundaries has been conducted, although CVWD is reconsidering restoring the Whitewater River subbasin as a single zone. The CVWD District Act limits zone charges to benefits from imported water used for direct groundwater recharge and in-lieu recharge from use of recycled water (Reyburn, 2015).

PAJARO VALLEY WATER MANAGEMENT AGENCY (PVWMA)

The PVWMA Agency Act provides for creating zones of benefit for areas within PVWMA's jurisdiction that will benefit from planning, studies, or any management program undertaken by PVWMA in a manner different from other areas within the agency's jurisdiction. Zones of benefit are established by a resolution of the board that describes the boundaries of the zones and may only be adopted following a noticed public hearing.

Two zones were established in 2010 based on delivered water (Carollo, 2010). Parcels along the coast with access to water delivered through PVWMA's coastal distribution system are in the Delivered Water Zone. All other parcels within PVWMA's boundaries are in the Outside Delivered Water Zone. In arriving at the current zone determination, several options were considered including geographic segmentation using 1/2 mile contours, hydrogeologic segmentation based on seawater intrusion, and zone of service segmentation based on availability of delivered water. The adopted variation in zone definition was intended to recognize that the water users closer to the coast benefit more (receive greater service) from PVWMA's system than inland water users.

MONTEREY COUNTY WATER RESOURCES AGENCY (SALINAS VALLEY BASIN) (MCWRA)

The Salinas Valley Basin zone of benefit has been defined based on geological conditions and hydrologic factors, which define and limit the benefits derived from MCWRA's reservoir operations. Historic work showed there to be five distinct sub-areas within the Salinas Valley Basin. Those sub-areas were first identified in DWR Bulletin 52, which established the division in accordance with sources of replenishment of groundwater for the respective areas served as indicated by direction of groundwater flow after the close of the 1944 irrigation season. Bulletin 52 emphasizes that these areas are not in any way to be confused with subbasins. This analysis resulted in the five original zones.

Historic work showed that each of the sub-areas within the Salinas Valley is hydraulically connected, but due to their varying geology and geography, they receive varying levels of benefits from the operation of the two existing reservoirs. Many of those same bodies of work have shown that the benefits that could be derived from proposed Salinas Valley Water Project facilities would also vary by geographic location within the Salinas Valley.

In 2001, a Technical Committee reviewed the sub-area delineations established in DWR Bulletin 52, and determined that there is information supporting those delineations and there is no known contradictory information. However, a review of the geology of the Salinas Valley indicates water-bearing alluvium extends south of the Upper Valley area, as delineated in DWR Bulletin 52, to beyond the Monterey/San Luis Obispo County line. This alluvium also extends west from the Salinas River area to the area surrounding San Antonio Reservoir. The original five sub-areas were, therefore, expanded to seven.

Prior to 2003, special benefit zones covering the Salinas Valley were known as: Zone 2 and 2A, which funded standby and availability charges associated with the operation and maintenance of existing facilities; and Zone 2B, which included approximately 12,800 acres of irrigated agricultural lands within the Castroville Seawater Intrusion Project (CSIP) distribution system. In 2003, Zone 2C was created and includes the lands that receive benefits from the Salinas Valley Water Project. Zone 2C overlays the previous Salinas Valley zones and was defined based on geological conditions and hydrologic factors, which define and limit the benefits derived from the reservoirs and the proposed changes to the operations, storage, and release of water from the reservoirs. Zone 2C is separated into the seven major hydrologic sub-areas described above.

The basis for inclusion within the Zone 2C zone of benefit consists of the following eight criteria reviewed and approved by the Technical Committee in 2001:

(a) There must be a hydro-geologic or flood protection basis for establishing benefit;

(b) The zone of hydrologic benefits is defined as land overlying water bearing alluvium that has hydraulic continuity with the Salinas River;

(c) The zone of benefit excludes narrow, likely shallow, channels off the main basin where pumping cannot induce an up-gradient recharge;

(d) Existing annexations that are non-hydraulically connected have been included since they are receiving benefits through physically installed pumping and piping equipment;

(e) The southern boundary of the zone of benefit is defined by the Monterey/San Luis Obispo County line;

(f) Lands immediately adjacent to San Antonio reservoir receive hydrologic benefits due to recharge of the underlying aquifer and receive recreational benefits afforded by their proximity to San Antonio reservoir;

(g) The boundary in the Fort Ord area is defined by the existing boundary of zone 2A. ;

(h) Any contiguous parcel that overlies a portion of the alluvial material that is in hydrologic continuity with the Salinas River has been included in a zone of benefit since the overlying portion of the parcel provides access to all hydrologic benefits (RMC, 2003).

Section 3.2.1 of the Salinas Valley Water Project Engineer's Report (RMC, 2003) describes the benefits and weighting factors assigned to each benefit in developing the Zone 2C charges. The benefits are identified as: (1) control of seawater intrusion; (2) flood control; (3) increased groundwater recharge; (4) groundwater quality; (5) timing and location of the recharge; (6) drought protection; (7) preservation of aquifer storage; and (8) recreation.

SAN BENITO COUNTY WATER DISTRICT (SBCWD)

SBCWD was formed by a special legislative Act in 1953. The original jurisdiction was valley-wide instead of county-wide. An early amendment to the Act, redefined the boundaries to be county-wide; however, taxing powers were limited to areas within zones of benefit. Five zones were created between 1953 and 1967 to fund specific projects. Only Zone 3 of those original five zones remains active. Zone 3 was formed in 1957 to finance construction and operation of the Hernandez and Paicines reservoirs and related groundwater recharge and management activities. The original Zone 1 practically overlapped with Zone 3 exactly and was dissolved. The other original zones were dissolved for the following reasons: the Zone 2 function was assumed by the Tri-County Water Authority; the Zone 4 function was turned over to the City of Hollister; and Zone 5 was temporary to finance engineering and hydrological studies to prepare development of facilities to distribute San Felipe water and was succeeded by the permanent operating Zone 6 (Creegan & D'Angelo-McCandless, 1977, pages I-2 – I-3).

The current Zone 1 encompasses the entire county and provides the funding base for specific SBCWD administrative expenses. The methodology used to define the Zone 3 boundaries could not be located. A master plan report prepared in 1977 by Creegan & D'Angelo-McCandless, Consulting Engineers, documents the formation of Zone 6, which establishes the assessment area for financing the capital and operating expenses of the San Felipe project (CVP). Zone 3 and Zone 6 overlap in areas that receive benefits from projects funded by the both zones.

The Zone 6 boundaries were determined primarily by land classifications within the area to receive CVP water. The foundation document for establishing the project benefit area was the U.S. Bureau of Reclamation's March, 1973, "Land Classification Appendix" for the Hollister Subarea, San Felipe Division, Central Valley Project. The Zone 6 area encompasses acreage referred to in the Land Classification Appendix as the Hollister Basin and San Juan Valley. Zone 6 boundary modifications were made in the above referenced master plan to eliminate non-irrigable lands in adjacent hills, for political considerations, and to observe parcel boundaries to simplify taxation.

SANTA YNEZ RIVER WATER CONSERVATION DISTRICT (SYRWCD)

SYRWCD was formed in 1939 for the primary purpose of protecting water rights on the lower Santa Ynez River following construction of two upstream reservoirs. Additional projects or exportation of water were also being studied, and the Cachuma Project was administratively authorized in the same year. For these reasons, the people of the Santa Ynez and Lompoc Valleys joined together to form a water conservation district. The purpose of SYRWCD is to protect, and if necessary, augment the water supplies of the SYRWCD. (Stetson Engineers, 2015). SYRWCD's role is essentially that of an oversight authority and it operates on a budget of approximately $500,000/year. Groundwater charges are incurred by the owners of water production facilities and are charged at uniform rates (for each category of water) within SYRWCD or each Zone thereof, based on the amount of groundwater produced (Wales, 2015).

There were three zones prior to 1995: the Santa Ynez River alluvial channel; the Lompoc Plain; and all others. In the course of preparing an AB3030 plan, SYRWCD convened a committee of five geologists who determined boundaries for three additional zones based on hydrogeological distinctions and groundwater recharge from the Santa Ynez River. While SYRWCD continues to be segregated into six zones, there are only two groundwater rate schedules: Zone A (Santa Ynez River alluvial channel), which accounts for 27% of the total groundwater pumping, and Zone B (Lompoc Plain, Lompoc Upland and Lompoc Terrace sub-basins), which accounts for 50% of the total groundwater pumping, are charged at a higher rate; Zones C, D, E, and F are charged a lower rate (Wales, 2015). Zone C encompasses all portions of the SYRWCD not included in the other zones, and Zones D, E, and F cover the SYRWCD's portion of three distinct upland basins.

UNITED WATER CONSERVATION DISTRICT

United Water Conservation District (UCWD) has established two zones. Zone A includes all lands lying within the boundaries of UWCD. Zone B was formed to pay for operation and maintenance of, and any improvements to, the Freeman Diversion project facilities. Zone B is a sub-area of Zone A that encompasses the portions within the UWCD boundaries of all DWR defined basins or subbasins down gradient of the diversion project. Since 2012, two of these basins have been re-labeled (Montalvo is now referred to as Oxnard Forebay; and North Las Posas is now referred to as West Los Posas), but the zone boundaries have not been re-evaluated (Morgan, 2015).

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Appendix B

Comments and Responses to Comments on Methodology

Meeting Summary
Technical Review Committee
October 20, 2015

Participants

Technical Review Committee:
Carl Hauge, California Department of Water Resources (Retired)
Randy Hanson, US Geological Survey
Rebecca Nelson, Stanford Woods Institute (as of January 1, 2016 University of Melbourne Law School)

Project Team:
George Cook, Santa Clara Valley Water District
Bassam Kassab, Santa Clara Valley Water District
Cameron Tana, HydroMetrics WRI
Laura Brown, HydroMetrics WRI
Charles Gardiner, Catalyst Group

Questions and Comments

Topic Introduced by Carl Hauge

- **Does the water budget include a bedrock flow contribution? More wells pumping from bedrock would reduce mountain front recharge.**
  Response: The water budget includes a bedrock flow contribution so wells pumping from bedrock potentially do affect the water budget. However, the distribution and extent of fractures connecting the Quaternary deposits into bedrock is generally unknown. Unless there is specific information showing the extent of hydrogeologic connection into bedrock, bedrock areas will not be considered hydrogeologically connected with the Quaternary deposits.
- **Will the confining layer under the aquitard be included in hydrogeologically connected areas?**
  Response: Yes.
- **Include a map of the recharge areas in the methodology technical memorandum.**
  Response: The reason such a map was excluded is that we did not want to include results of implementation steps in the methodology memo. The map will be included in the technical study report.
- **Does "groundwater balance" mean a water budget? Use "water budget" to emphasize integrated resource management.**
  Response: Terminology in the memo is changed from "groundwater balance" to "water budget."
- **Randy Hanson also commented that conjunctive use should be made part of the metric.**
  Response: The water budget includes conjunctive use of surface water supplies and will be explicitly stated in discussion of water budget in the memo. For example, District activities in calendar year 2013 resulted in 96,500 acre-feet of managed aquifer recharge and 205,300 acre-feet of in-lieu recharge compared to 39,500 acre-feet of

natural recharge (SCVWD, 2014). Most of the District activities that provide benefit to groundwater users are conjunctive use activities.

- **Overall, this is a good exercise because you will develop more detail about managing groundwater, which is very much needed across the state.**
  Response: Comment noted.
- **The specificity of the zones shouldn't exceed the specificity of the data.**
  Response: The zones will, of necessity, exceed the specificity of the data as the zones will need to define the specific parcels that will pay groundwater charges. The zones will be based on the best approximation of the areas benefitting from similar District activities as supported by the available data. The study will also develop a procedure to apply for exemptions from the zones, which will increase the specificity of the data by allowing groundwater users to provide data for specific locations that could result in redefining zone boundaries in response to more location-specific data.
- **Have you considered the possibility that you will come up with the same zones?**
  Response: Without good information to change the zones, they will remain the same. The District is looking for an honest, unbiased evaluation of the zones of benefit without a preconceived outcome.

Topic Introduced by Randy Hanson

- **The fault lines may have a significant effect on groundwater flow, such as the Silver Creek Fault and underlying Vasona Creek.**
  Response: We will revise the memo to better recognize this possibility and make sure to evaluate groundwater flow in the vicinity of faults.
- **Are you looking at the benefits of other activities (besides District programs)?**
  Response: We are evaluating beneficial non-District activities to make sure benefits that may result from those non-District activities are not attributed to District activities in recommending modifications to zones. However, separate zones for areas where benefits from non-District activities occur will not be recommended.
- **Are you considering passive benefits? For example, the San Jose Water Company wells are constructed such that they provide a deep conduit to increase recharge of deep aquifer layers and provide water that can be re-pumped in to prevent subsidence.**
  Response: We will consider passive benefits that are identified in a similar manner to non-District activities discussed above, but there needs to be evidence that the passive benefits have improved or are improving the water budget.
- **Are there also areas where additional activities could have negative effects that could be defined as zones of hazard, e.g., pumping in the shallow central area could remobilize contaminants?**
  Response: Evaluation of negative effects from non-District activities is beyond the scope of this study.
- **Could District groundwater programs have adverse effects, such as increasing the artesian effects from "overfilling" the basin? The USGS model shows that the basin could be refilled to a point that could result in recharged water being lost back to the streams.**
  Response: The District manages its activities to minimize the risk of adverse effects. This possibility will not affect the definition of zones of benefit, which will be based on benefits resulting from District activities.
- **Oxygen and deuterium isotopes have been used to track the extent of recharge. Could that approach be used here?**

Response: Yes, as stated in the methodology memo, isotopic analyses that differentiate ambient groundwater from recharge water will also be considered. We have identified these data collected by the GAMA program (Ray, 2009) and as part of the Olin remediation project (MACTEC, 2009).

- **The overall groundwater quality of the basin is very good, much better than many other basins in California. What is the quality concern, and what water quality benefits are you looking for?**
  Response: This evaluation will occur in areas where there is an identified quality concern. For example, nitrate concentrations are high in ambient groundwater in portions of the Llagas subbasin. Imported water used for managed aquifer recharge has a dilution benefit by adding water with low nitrate concentrations to the groundwater balance (MACTEC, 2009). Perchlorate could be another relevant quality concern.
- **How will the Santa Clara Valley comply with SGMA and will activities be credited?**
  Response: SCVWD is named as the exclusive groundwater management agency for Santa Clara County, and will be updating the groundwater management plan in accordance with SGMA requirements. The plan will cover the Santa Clara and Llagas groundwater subbasins. The updated groundwater management plan will reflect the District activities that provide benefits used to define the zones of benefit.

Topic Introduced by Rebecca Nelson

- **Have the recharge areas changed over time?**
  Response: Recharge facilities have changed over time in that they have come online at different times and the water delivery to them varies with availability and recharge needs. The differences in timing of recharge for different areas will be evaluated in the analysis to identify benefits from recharge activities with different histories.
- **Have you thought about changes in water use over time, from agriculture to urban, and changes to the levels of conservation? Describe the background levels of land use change that could explain the differences that are not the result of District programs.**
  Response: The memo discusses evaluation of net demand to assess whether improving groundwater conditions can be attributed to District activities. We will revise the memo to clarify that land use change could cause changes in net demand and the study will include a high level description of land use changes that have caused changes in net demand.
- **The Great Oaks lawsuit may change the definitions you are using.**
  Response: District staff will ensure the study complies with all legal requirements including any requirements resulting from a final decision rendered in the Great Oaks case.
- **It makes sense that if there is a benefit, users pay for it.**
- **Include conservation as a beneficial activity.**
  Response: District conservation activities are included as providing benefit, but will likely not be a major factor in defining zones because those activities and benefits are widespread throughout the District.
- **Will the zones cover the entire basin?**
  Response: The zones may not cover the entire basin. Only areas identified as benefitting from District activities will be included as zones. For example, bedrock areas that don't receive water deliveries from SCWVD likely will not be part of the zones unless there are data showing a hydrogeologic connection into bedrock from Quaternary deposits.

- **Will planned activities substantially change the area of benefit?**
  Response: We will evaluate benefits from planned activities with available information, but the study will also develop a procedure for revising zones in the future to reflect benefit changes and a recommended timeframe for regularly reviewing and updating the zones.
- **Both Carl Hauge and Rebecca Nelson commented that it is good to be developing a methodology that can be repeated in the future.**
- **What would happen if there is disagreement between the model and physical data?**
  Response: If either of the lines of evidence demonstrate that groundwater users in an area benefit from a set of District activities, then the area will be mapped as benefitting from that set of District activities. For example, there may be factors that result in the data not clearly demonstrating a benefit, or the model may not show improvement greater than the error of calibration. Therefore, if the data show benefits that can be attributed to District activities, or if the model shows improvement greater than model uncertainty, then a benefit will have been demonstrated.
- **Randy Hanson commented that model accuracy depends on what you are using for calibration. You need to use higher order observations, stream flows, etc., not just groundwater levels, to calibrate the model. Note that the USGS also looked at rejected infiltration.**
  Response: We will be using the groundwater models as calibrated by the District to groundwater levels. This is appropriate because the methodology uses the model to look at head differences under different scenarios. Calibrating the model to other observations is not part of the study’s scope.
- **It is good to quantify uncertainties in the model. Also discuss how the uncertainties will influence how you draw boundaries.**
  Response: Model results need to show groundwater level improvement greater than model uncertainty to demonstrate benefit. Where model results define boundaries, recommended modifications to zones of benefits will only be based on areas where modeled groundwater level improvement is greater than model uncertainty.
- **Carl Hauge commented that relying on the model vs. demonstrated increase in head could be controversial. Landowners will trust measurements over model results.**
  Response: Ideally, both the data and the model will show similar results. However, as discussed above, measured data may not be available in all areas or data may not demonstrate benefit due to other factors. In such cases, using the model will isolate effects of District activities and, therefore, it is appropriate to use model results.
- **How do you connect groundwater levels to water supply reliability?**
  Response: In general, higher groundwater levels indicate higher water supply reliability due to lower risk of wells drying out, lower risk of well damage from aeration of screens, higher yields, and lower pumping costs.
- **Carl Hauge noted that developing a scale of reliability would be a difficult exercise.**
  Response: Yes, a reliability scale would be difficult, which is one of the reasons why relative differences in benefits from a similar set of District activities will not be used to define zones.

- **TRC members expressed appreciation for the presentation and discussion.**
- **The TRC agreed to provide any additional questions or comments by November 6, 2015.**

Comments Provided by Rebecca Nelson via email November 10, 2015

- **Current versus planned activities: The document refers to zones reflecting areas receiving benefits from current and planned District activities. The District should consider whether it is equitable/legal to include within a zone an area that will only receive benefits in the future (and if so, how far into the future is justifiable), or whether the boundaries of zones should change in the future in response to the commencement of significant future District activities. The document also occasionally refers to “potential” activities. This sounds a little too uncertain or hypothetical to justify zone boundaries, whereas “planned” activities seems more justifiable.**
  Response: Planned District activities will be considered as a different set of activities than current activities. An area that will only receive benefits in the future from planned activities will be recommended as a separate zone from areas that receive benefits from current activities. Likewise, areas that receive benefits from current activities may be recommended to be divided into multiple zones if only parts of those areas will receive benefits from planned activities.

  A process for conducting future reviews of zones of benefit that will be developed as part of the study. A review of zone boundaries based on benefits from new or expanded District activities will be included in that process. We will also revise the methodology memo to only include planned activities and not potential activities.
- **Quality as a benefit: In relation to quality as a benefit, it would be helpful to explain the statement on page 15 that connects in lieu recharge with groundwater protection activities: “Areas that benefit from … in-lieu recharge activities are also assumed to benefit from the groundwater protection activities.” I wasn't clear on the mechanism for in-lieu recharge to influence groundwater quality.**
  Response: This does not refer to a physical mechanism for in-lieu recharge to influence groundwater quality. Groundwater protection activities provide broad benefits to groundwater quality throughout the groundwater basins. Areas where there are in-lieu recharge benefits to groundwater supply are assumed to also benefit from groundwater protection activities because those activities protect (i.e. preserve) the groundwater supply that is more reliable due to in-lieu recharge.
- **The overall approach is clearly well thought out, and the District should be congratulated on its effort and approach, which appears to be uniquely rigorous in the state.**

Meeting Summary
Joint Meeting of the Water Retailer Water Supply and Groundwater Committees
October 22, 2015

Joint Meeting of the Water Retailer Water Supply and Groundwater Committees

Zone of Benefit Study

- **Have notices gone out for the October 28 small group briefing meeting?** Response: Notices went out October 17, 2015.
- **Who is commenting on the Methodology Technical Memorandum?** Response: We received verbal comments from the two attendees at the October 28 meeting: a mutual water company representative and interested citizen. We also received written comments from Stanford University.
- **Is the District taking frequent measurements of subsidence?** Response: To monitor subsidence in the Santa Clara Subbasin, the District:
    - monitors two 1,000-foot deep extensometers that measure vertical ground motion
    - conducts annual benchmark leveling surveys along three cross valley level circuits
    - measures water levels at ten subsidence index wells to ensure they remain above established thresholds.
- **What are the main things you hope to get out of the Zone of Benefit Study?**
- Response: The District's goals for the Study are: 1) Develop a well comprehensive process for evaluating the Zone of Benefit boundaries based on the latest information and technology, 2) ensure that the boundaries are accurate and reflect hydrological conditions in a way that groups pumpers based on the benefits they receive from current District programs, and 3) develop processes for exemption requests and future changes.
- **Will this study help with groundwater modeling?** Response: The study will use groundwater modeling. It is possible that evaluation of model runs will inform future groundwater modeling improvements.
- **Does the Technical Memorandum outline what is different now about this approach?** Response: The technical memorandum outlines what is different from previous work, but does not outline differences with what was presented in our first presentation to the retailers.
- **This will presumably help the District comply with Proposition 218.**
- Response: Proposition 218 restricts local governments' ability to impose assessments and property-related fees and requires elections to approve many revenue raising methods. The District does not believe that its groundwater charges are subject to Proposition 218; however, it has also ensured that its groundwater charges are adopted in a manner consistent with Proposition 218 as a matter of policy. The study is consistent with this policy in that it will help ensure that the District's charges are appropriately aligned with the costs of providing service and the benefits payors receive
- **Will there be new information about the hydrogeology?** Response: We will use available information about hydrogeology, including a new study published by the U.S. Geological Survey in the last two years.

Participants

George Cook, Aaron Baker, Water Retailers
Cameron Tana, HydroMetrics WRI

Charles Gardiner, Catalyst Group

Meeting Summary
Stakeholder Small Group Meeting
October 28, 2015

George Cook provided an overview of the purpose of the Groundwater Zone of Benefit Study and Cameron Tana reviewed the study methodology.

Comments and Questions

1. **Have you sampled salt in the groundwater to determine where the saltwater intrusion is?**
   Response: Yes, Figure 5 of the draft technical memo on the study methodology is based on ongoing salinity monitoring in groundwater wells.
2. **Where does the replenishment come from to reduce the intrusion?**
   Response: SCVWD captures surface water runoff and imports water from the State Water Project and Central Valley Project. These sources provide water for managed and in-lieu recharge that maintain groundwater levels and help to prevent subsidence and saltwater intrusion.
3. **The resiliency of the basin since 1980 is impressive.**
   Response: comment noted.
4. **The 1975 to 1979 period was a severe drought, which could have contributed to the saltwater intrusion.**
   Response: Yes, climatic conditions can affect groundwater conditions such as saltwater intrusion. However, much of the advancement of the saltwater intrusion from 1945 to 1980 as shown in Figure 5 was related to declining and depressed groundwater levels related to increases in groundwater pumping.
5. **Higher average rainfall after 1980 also provided a benefit to the groundwater basin and helped reduce saltwater intrusion.**
   Response: Yes, climatic conditions can improve groundwater conditions such as saltwater intrusion. The study methodology evaluates climatic conditions to identify groundwater benefits that can be attributed to District activities and are not the result of climatic conditions.
6. **The groundwater basin is connected only to a certain point. There are wells in South County that are only a half-mile apart and show very different groundwater levels.**
   Response: Water levels in individual wells can vary greatly, even if the wells are located in close proximity. This difference can be caused by either hydrogeologic difference, or by differences in well construction or adjacent pumping. The study methodology includes evaluation of groundwater level trends to evaluate whether benefits extend throughout mapped alluvium.
7. **Are you using actual well log data to determine the extent of the alluvium and the hydrogeology of the basin?**
   Response: Due to the size of the basin and limited availability of well logs along the edge of the basin, we are not evaluating well log data to determine extent of the alluvium and hydrogeology. However, we are using published reports, such as those by the U.S. Geological Survey and California Geological Survey. Those reports used actual well log data.
8. **The study should look at well data throughout the zones, not just information down the center of the basin.**
   Response: The published reports that will be used to map hydrogeology used well data throughout the basin. The study of groundwater levels and other data will include available data from throughout the basin.

9. **At the New Avenue Mutual Water Company, we have some well data that dates back to 1978. More recently, we have collected well data more regularly and more extensively. We can make this data available.**
   Response: The draft technical memorandum discusses the use of stakeholder data. Data being considered for use will be evaluated to verify adequate measurement protocol and ensure there are sufficient regularly measured static groundwater levels to evaluate trends during times of increased volumes from District activity. Stakeholders that wish to share their well data to support this evaluation should submit all information about the well such as a well log and construction information.
10. **The groundwater levels in the New Avenue Mutual Water Company wells are where we would expect them to be given the drought and weather conditions.**
    Response: The study methodology evaluates climatic conditions to ensure groundwater benefits can be attributed to District activities and not climatic conditions.
11. **Since the San Felipe project went online, groundwater levels went from 145 feet to 130 feet.**
    Response: The evaluation of whether a benefit is occurring requires looking at other factors than just the change in water levels. Increasing demand (pumping), wet years, and drought will cause water levels to decline or increase independently of any benefit from District activities. The study will evaluate the water level trends by comparing the observed and expected trends with trends (i.e in a drought period, a decline in water levels would be expected; if the observed trend is increasing or stable, a benefit from District activities would be indicated). The study methodology will assign benefits to an area only if there are periods of stable or increasing groundwater level trends that can be attributed to District activities.
12. **We don’t see a benefit from recharge activities at Church Avenue and along Highway 101.**
    Response: The study intends to document where groundwater benefits are demonstrated. The stakeholder review process will provide an opportunity to review the findings prior to the District adopting the zone boundaries.
13. **How do you measure groundwater pumped by farmers?**
14. Response: Groundwater pumping is measured by either metering or through the use of standardized water use factors. Meters are required for wells that meet the following volumetric thresholds:

Zone	Volumetric Threshold for Metering (AF/Yr)	
	Municipal	Agriculture
W-2	1	4
W-5	2	20

    Factors used to estimate groundwater pumped by smaller users include the number of residents, lawn area, and crop type.

15. **There is a discrepancy between actual water use and what the formula determines for unmetered groundwater pumping.**
    Response: It is not practical to meter all wells due to the cost for installing, maintaining, and operating (including reading) meters. The water use for smaller accounts is an estimate based on self reported information and standard water use factors. The factors are based on published studies and industry standards and are regularly reviewed and updated as necessary. Although the volume pumped from smaller wells is an estimate, over 90% of the groundwater pumped is from metered wells.

16. **The residential use in South County is not very large. Farmers are cycling three crops a year and using a lot of water.**
    Response: The relative use of water by different stakeholders will not be a consideration for how zones are mapped. The zones will be mapped based on the extent of benefit from District activities. Groundwater charges are assessed based on use and volume.
17. **How do you forecast precipitation trends?**
    Response: We are looking at past precipitation trends in the historical data, not forecasting future precipitation.
18. **Have you considered farming operations and the amount of water that evaporates, get taken up by plants, and recharged back into the ground? At least 50% is percolating back into the ground.**
    Response: We are considering changes in net demand to evaluate whether changes in groundwater conditions can be attributed to District activities. Net demand by farming will mostly be related to crop evapotranspiration demands and not changes in return flow. The groundwater models that will be used as part of the evaluation account for return flow.
19. **What is the time it takes for water to percolate from recharge ponds to the 300-foot aquifer? Are you considering that time when you are looking for the effects of groundwater programs?**
    Response: We will consider the delay in effect from the implementation or changes in the recharge activity in the data evaluation.
20. **Show a chart of the amount of water put into the basin and the precipitation patterns. Show the volumes of natural recharge and the amount of District recharge.**
    Response: This information will be included in the study.
21. **The groundwater quality in the south County is very good. If anything, recharge activities add contamination to the basin.**
    Response: Recharge activities can actually improve water quality by diluting certain contaminants such as nitrate or perchlorate. The District monitors the quality of the water at our recharge facilities. Recharge water quality is generally good, with most water quality indicators similar to or better than receiving water throughout the year. Groundwater quality benefits from managed recharge activities will be assessed.
22. **Where did perchlorate in the groundwater basin come from?**
    Response: Perchlorate has been attributed to contamination from Olin Corporation’s former road flare manufacturing facility in Morgan Hill. (SCVWD)
23. **For the most part, people take water for granted. The New Avenue Mutual Water Company has 108 shareholders; only about 10 shareholders attend the annual meeting.**
    Response: comment noted.
24. **How detailed is the methodology for prescribing the analysis and results?**
    Response: The methodology is detailed for describing the analysis, but does include flexibility. Any changes to the methodology will be fully documented in the study report. The methodology does not prescribe results.
25. **Is there a time we can present data that our area doesn’t benefit from recharge programs? Our area has static water levels and steady consumption over the last 30 years. We have cut water use by 25%, but we haven’t seen any change in the water levels. Some surface springs have dried up, but the 300-foot aquifer doesn’t show much change.**
    Response: Please provide the data by the end of February if you would like it to be considered for this study.
26. **New users need to pay for new water.**
    Response: comment noted.

27. **Be objective in the analysis. Deal with the data to reach conclusions. Don't be subjective.**
    Response: The study methodology is based upon published studies and data. Hydrometrics will be objective in their data analysis.
28. **South County lost control of the water district when Gavilan merged with SCVWD.**
    Response: Comment noted.
29. **What do you mean by visually evident changes when reviewing the data?**
    Response: We mean that when any reasonable person reviews the graph of the data, they should be able to see the trends that we are describing. We will not use statistics to state that there is a trend that is difficult to see. Statistics will only be used to quantify the visually evident trend.

Participants

Loverine Taylor, Portola Valley
Alan Heinzen, New Avenue Mutual Water Company
Vanessa de la Piedra, SCVWD
George Cook, SCVWD
Bassam Kassab, SCVWD
Cameron Tana, HydroMetrics WRI
Charles Gardiner, The Catalyst Group

5750 Almaden Expressway, San Jose, CA 95118-3614 | (408) 265-2600 | www.valleywater.org

Santa Clara Valley
Water District

April 18, 2016

Mr. Tom Zigterman
Director - Water Resources & Civil Infrastructure
Stanford University
327 Bonair Siding
Stanford, CA 94305-7272

Subject: Response to Stanford Comments on the Santa Clara Valley Water District Zone of Benefit Study

Dear Mr. Zigterman:

The Santa Clara Valley Water District (District) received Stanford's letter dated November 5, 2015 providing comments on the Draft Technical Memorandum, Methodology for Evaluating Groundwater Zones of Benefit. The District's responses to your specific comments are attached. These, along with other comments received and responses, will be posted on the study website and included in the Preliminary Zone of Benefit Study Report.

In summary, the District believes the current study methodology addresses your comments concerning hydrogeologic and hydraulic variability and accounting for non-District activities. The comment regarding a groundwater charge credit is noted, but is beyond the scope of this study, which is focused on the extent of the zones of benefit, rather than rates or credits applied within those zones.

Thank you for providing your comments on the study. If you have any questions, please call me at (408) 630-2964.

Sincerely,

George E Cook Jr

George Cook, P.G.
Associate Engineering Geologist
Groundwater Monitoring and Analysis Unit

cc: J. Fiedler, G. Hall, V. De La Piedra
Cameron Tana, Hydrometrics Water Resources

Attachments: Stanford Comment Letter Dated November 5, 2016
District Response to Stanford Comments

Stanford University SUSTAINABILITY AND ENERGY MANAGEMENT

Mr. George Cook
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118

November 5, 2015

Subject: Santa Clara Valley Water District Zones of Benefit Study
Stanford's initial comments on the ***Draft Technical Memorandum, Methodology for Evaluating Groundwater Zones of Benefit*** (Hydrometrics WRI, September 2015)

Dear Mr. Cook:

Stanford University appreciates the opportunity to provide comments on the *Draft Technical Memorandum, Methodology for Evaluating Groundwater Zones of Benefit,* Hydrometrics WRI, September 2015 (hereinafter referred to as the Draft Tech Memo). As you are aware, the technical, legal and equitable basis for the Santa Clara Valley Water District's (District) groundwater pumping charge has long been an issue for the University. The University is encouraged by the District's study and is supportive of the District's efforts to take a hard look at the current benefit zones supporting the District's groundwater charge. Stanford provides the following comments to inform the Draft Tech Memo and the District's Zones of Benefit study process going forward.

1. The Zones of Benefit study should account for hydrogeologic and hydraulic variability throughout the Zones and sub-areas within the Zones.

   Stanford requests that the Zones of Benefits analysis investigate and recognize the unique characteristics of the San Francisquito Cone from which Stanford and other local pumpers derive groundwater supply. The axis of this physiographic feature closely coincides with the modern-day San Francisquito Creek channel and is a source of groundwater on either side of the Santa Clara-San Mateo County line. The County line is the current Bulletin 118 boundary separating the Santa Clara and San Mateo Subbasins (Department of Water Resources Bulletin 118 - Update 2003). Hydrogeologic continuity across this boundary has been observed and reported in DWR investigations, and the alluvial fan of San Francisquito Creek was historically termed the San Francisquito Groundwater Area (Bulletin 118-1, 1967). Within this area, wells of distinctively favorable yield and quality have been developed and used for municipal and agricultural purposes since the early 1900s. These distinctive characteristics were not recognized in the District's 1963 W2 Zone classification and we now urge the District to acknowledge the importance of these physiographic and hydrogeologic features that have long been recognized locally through their effects on groundwater development and protection.

   The Zones of Benefit study also should recognize that seawater intrusion and subsidence impairments vary throughout the Zones, and have been determined to be minor and relatively insignificant in the

San Francisquito Cone area. While concerns regarding degradation of freshwater aquifers in the Palo Alto area were raised decades ago, ultimately water quality degradation was determined to be due to improperly sealed wells and vertical migration from shallow brackish aquifers downward through well structures, not seawater intrusion. The presence of Bay muds and the configuration of the primary supply aquifers in relation to the Bay were not conducive to intrusion as in the southern part of the Valley. Subsequently, the local problem of vertical migration through wells was effectively mitigated through well sealing practices. Similarly, as should be apparent from previous studies available to the District, a lack of measureable subsidence on and around the Stanford campus, even during periods of groundwater decline in the 1950s and 1960s, is consistent with the coarse nature of aquifer materials in the San Francisquito Cone area where most of the local groundwater supplies are developed. From these studies, the San Francisquito Cone area is far less vulnerable to localized subsidence due to pumping than other areas of the basin. The Zones of Benefit study must take into account this local variability.

2. The Zones of Benefit study should identify and account for local or regional groundwater management benefit in the same manner as District activities that benefit the zones or subareas of zones

In addition to the hydrogeologic and hydraulic factors discussed above, the Zones of Benefit study should assess historic and current benefits of District and local activities on the basis of actual effects to groundwater availability and quality. Stanford refers the District to its own historical technical studies concerning the significant effects of overdraft in the region and the myriad solutions and projects that were brought to bear – by the District and local interests – to address declining water levels, seawater intrusion, and subsidence. We note, for example, that while the District once considered a cross valley conveyance to deliver surface water to cities and areas in the north and northwest areas of the basin, water imported by the District ultimately was delivered to other areas of the basin to mitigate overdraft in the southern areas. The Zones of Benefit study must recognize that conditions of groundwater decline and overdraft in the northwest portions of the basin were addressed locally, at great expense, by connecting to the San Francisco water system at roughly the same time that the District's surface water imports commenced in the southern part of the basin. These distinct local activities, which continue today, addressed groundwater conditions in the northwest portions of the basin, and should be recognized in the Zones of Benefit study and in future District decisions concerning groundwater fees.

Proper allocation of benefits is a particularly important concern to the University with respect to methodologies pertaining to analysis of groundwater levels. Absent evaluation of local activities and conditions at appropriate local scales, along with their relative effects on historical groundwater levels, the study will incorrectly characterize improved and stabilized groundwater levels solely to District activities. As discussed below under Comment 3, local activities by Stanford and others in the

San Francisquito Creek groundwater area have long been recognized to provide benefits that are not the result of District activities.

The University previously discussed with the District the University's own local groundwater management efforts, such as augmentation of natural recharge through Lake Lagunita located on campus which has a direct, significant and beneficial impact on the local groundwater supplies and conditions in the San Francisquito Creek cone area where Stanford's wells are located. The viability of recharge augmentation is supported in historical reports of the geology and replenishment sources of the San Francisquito Cone (DWR Bulletin 118-1, 1967). The District's current proposed study should identify, quantify and incorporate these local and regional activities where concurrent efforts of non-District entities have resulted in the protection and augmentation of local groundwater supplies for the past several decades. The University is not aware, for example, that local groundwater protection activities, such as augmented recharge in Lake Lagunita, were previously recognized or accounted for by the District. This adds to our concern that the proposed analyses of groundwater levels (e.g., Draft Tech Memo: Analysis Applied to Groundwater Level Data) will not be based on an appropriate level of detail or historical perspective. Such detail and perspective can only be achieved through a major outreach to water entities and users throughout the District, which is clearly not part of the methodologies described in the Draft Tech Memo.

3. The Zones of Benefit study proposes to employ groundwater modelling

As stated in the Draft Tech Memo (Groundwater Model Simulations), the use of groundwater flow models is proposed as a "second and equivalent line of evidence evaluated for the effect of District activities in different areas." The University is not aware that the District's past or current groundwater flow models are sufficiently refined and calibrated to meet the stated objectives in the Draft Tech Memo in the area of the Santa Clara-San Mateo Subbasin boundary where Stanford's groundwater resources occur. Therefore, it is difficult to see how the District's study will appropriately allocate benefits using such a tool. To the extent that a groundwater modeling is employed in the Zones of Benefit study, Stanford would like the opportunity to review and evaluate the District's model and to work with the District to incorporate appropriate information and data concerning the relative benefits of local, non-District groundwater management and augmentation activities. Stanford has monitored local groundwater conditions and observed local benefits and effects of its own groundwater management activities in the San Francisquito Creek cone area, commencing with the historical development of local groundwater resources and importation and augmentation of surface water to address groundwater decline. To the extent that groundwater data Stanford possesses might be useful and inform the District's current study, we would be happy to meet and discuss further.

4. The District should consider restoring the Groundwater Charge Credit for local investment in in-kind groundwater management activities.

   In recognition of the local groundwater management programs and projects that have been implemented by parties other than the District, the Zones of Benefit Study should consider restoring the groundwater charge credit that once existed in the District groundwater charge structure. The credit recognized the benefits and investment of various entities in certain areas of the basin, including the City of Palo Alto and Stanford University, to import surface water from San Francisco in lieu of or to reduce the use of groundwater. These activities are precisely what the Zones of Benefit study will attempt to quantify as it relates to District activities, and there is no reason the study should not also consider and incorporate local groundwater management efforts that result in the same Basin benefits. Similarly, the study should quantify and incorporate local groundwater augmentation activities, such as Stanford's groundwater replenishment activities at Lagunita on the Stanford Campus, and should include programs to credit and reimburse local entities for those groundwater benefits.

5. The Zones of Benefit study must consider weighting of the relative benefits of certain activities in various areas of the basin.

   The Draft Tech Memo discusses other groundwater charge programs and cost allocation/ benefit assessment methodologies employed by other agencies in California. One feature of some of the more successful of these methodologies is a "relative weighting" concept, whereby the benefits to certain areas of the basin are weighted relative to the benefits received in other areas for that particular benefit. For example, whereas direct and in-lieu recharge may provide a water quality benefit to a broad area within a zone, certain sub-areas of the zone may receive a much greater benefit than other areas. The Zones of Benefit study should be refined such that the relative benefits are accounted for in the development of new zones, or within the components of the groundwater charge assessed within a particular zone. Similarly, the study should account for the relative value of particular benefits (e.g., groundwater elevation benefits vs. subsidence benefits), and should be designed to allocate the actual District costs to provide certain benefits (e.g., the cost of providing water quality benefits vs. the cost of providing protection against subsidence).

The Draft Technical Memorandum should be revised to reflect these general scoping comments. In addition, while not a complete review, we do have some examples of specific comments on the text of the Draft T.M.:

> Page 1, second paragraph, second sentence: the sentence should be revised to read: "Although the District is not aware of any specific problems with the existing Zone of Benefit designations, *the*

District has received requests for a benefits analysis and recognizes that it is important for the District to periodically undertake…".

Page 1, fourth paragraph, third sentence: the sentence should be revised to read: "Unless adjacent bedrock areas *and areas that are hydraulically up-gradient from the District's recharged areas are receiving District water supply, it will be assumed that the areas are not within the zone of benefit…*".

Page 2, point 4: replace "demonstrate" with "assess".

Page 3, third paragraph, first sentence: revise to read "The Study will *identify and* evaluate the ways…".

Page 3, add another paragraph that reads: "*The Study will also consider non-District import of water supply by groundwater users (which decreases their use of groundwater), and recharge conditions and activities conducted by groundwater users.*".

We look forward to working with the District on this important Study. Please let us know if you would like to meet and discuss these comments, the Study process, or Stanford's understanding of the groundwater conditions in the San Francisquito Cone area.

Sincerely,

Tom W. Zigterman

Tom W. Zigterman, P.E., D.WRE

Director – Water Resources and Civil Infrastructure

Response to Comments
Received from Stanford University
November 5, 2015

Comments

1a. The Zones of Benefit study should account for hydrogeologic and hydraulic variability throughout the Zones and sub-areas within the Zones.

Response: Hydrogeologic features will be mapped to assess the extent of hydrogeologic connection to District activities. If information can be provided to show features that limit the hydrogeologic connection in the Quaternary deposits, those features will be considered. The sections of DWR Bulletin 118-1 referenced by the commenter and Bulletin 118 updates will be reviewed, along with other relevant hydrogeologic studies, to evaluate the connection of the San Francisquito Cone with Quaternary deposits of the Santa Clara Plain. However, the possibility that adjacent areas have different yield or hydraulic characteristics does not preclude a hydrogeologic connection; therefore the different yield or hydraulic characteristics do not necessarily prevent the occurrence of a groundwater benefit from District activities within an area. The data analyses are meant to test the assessment of hydrogeologic connection of an area with District activities and available data should account for any hydrogeologic and hydraulic variability that limits the extent of a benefit to an area.

1b. The Zones of Benefit study should recognize that seawater intrusion and subsidence impairments vary throughout the Zones, and have been determined to be minor and relatively insignificant in the San Francisquito Cone.

Response: Benefits from District activities may take the form of improved groundwater supply reliability via improved groundwater levels, improved groundwater quality, and/or the prevention of seawater intrusion and subsidence. Areas receiving reasonably similar aggregate benefits from similar sets of District activities will be grouped together in the recommended zones.

2a. The Zones of Benefit study should identify and account for local or regional groundwater management benefit in the same manner as District activities that benefit the zones or subarea of zones.

Response: The methodology addresses the commenter's point that "Absent evaluation of local activities and conditions at appropriate local scales, along with their relative effects on historical groundwater levels, the study will incorrectly characterize improved and stabilized groundwater levels solely to District activities." Non-District, non-groundwater supplies of water will be subtracted from water demand to calculate a water supplier's net demand for District water and groundwater over time for the supplier's service area. When net demand is decreasing due to local activities, an improving groundwater level trend will not demonstrate a benefit from District activities (see Table 1 in draft memo). The draft memo refers to "retailers" net demand in this discussion, but that will be revised to "water suppliers" to clearly include suppliers that do not receive surface water from the District.

2b. The University is not aware, for example that local protection activities, such as augmented recharge in Lake Lagunita, were previously recognized or accounted for by the District. This adds to our concern that the proposed analyses of groundwater levels will not be based on an appropriate level of detail or historical perspective. Such detail and perspective can only be achieved through a major outreach to water entities and

users throughout the District, which is clearly not part of the methodologies described in the Draft Tech Memo.

Response: Local recharge quantities will be considered in the calculation of non-District net demand discussed in the response to comment 2a. Please provide data showing these quantities over time. There is discussion in the technical memorandum about using groundwater level data provided by stakeholders, but the memo will be revised to clarify that other information from stakeholders, including data related to the calculation of net demand, will also be considered.

The Draft Tech Memo focuses on the technical methodology, but outreach is a major part of the project. The stakeholder outreach plan is intended to provide a transparent process that includes public access to the data used and provides the opportunity for interested parties to submit supplemental data that they believe would influence the benefit assessment. The study has been discussed in several Water Retailer Groundwater Subcommittee meetings, and updates will continue to be provided through that forum as the study progresses. A web site providing the tentative study schedule and comment opportunities as well as links to documents developed as part of the study has been created (http://www.valleywater.org/ZoneofBenefitStudy/). Stanford University has been added to the list of those to receive project updates and small group briefings.

3. The University is not aware that the District's past or current groundwater flow models are sufficiently refined and calibrated to meet the stated objectives in the Draft Tech Memo in the area of the Santa Clara-San Mateo Subbasin boundary where Stanford's groundwater resources occur.

Response: As stated in the Draft Tech Memo, we will ensure that the benefits we identify using the model or other analytical tools are the result of District activities, and not model uncertainty. We would request that you provide any Stanford data that might be useful for the groundwater level analysis. As described in the Draft Tech Memo, data being considered for use will be evaluated to verify adequate measurement protocol and ensure there are sufficient regularly measured static groundwater levels to evaluate trends during times of increased volumes from District activity. Stakeholders are encouraged to submit all information about their wells, such as a well log and construction information, to the District. We appreciate your offer to meet and discuss your data, and will contact you to schedule a meeting.

4**. The District should consider restoring the Groundwater Charge Credit for local investment in-kind groundwater management activities.**

Response: The zone of benefit study is limited to recommending new or modified zones based on benefits from District activities and does not encompass policies related to fees and charges. If the District Board of Directors approves changes to the zones of benefit, a separate rate study will be performed. Restoring a groundwater charge credit would be a separate policy consideration.

As stated in the response to comment 2a, local activities will be considered to ensure that benefit is not assigned to District activities when the benefit may result from non-District activities. Only when benefit from District activities can be demonstrated will that benefit be used to define zones of benefit even though there may be additional benefits that result from local investment.

5. The Zones of Benefit must consider weighting of the relative benefits of certain activities in various areas of the basin

Response: Separate zones will be defined for areas where groundwater users receive benefits from different sets of District activities. This concept has been used by other agencies in California as discussed in the Draft Tech Memo Appendix A and is also consistent with requirements of the District Act.

Our research and interpretation of groundwater benefit zones established by other California agencies does not present examples of a "relative weighting" concept as described by the commenter. The relative benefit is likely to continuously change with distance from District activities, so defining zones based on a specified level of benefit would be arbitrary. The methodology includes evaluation of different types of benefits in order to assess the extent of benefit to the water budget from specific District activities. However, the different types of benefit will not be used to assess or weigh relative benefit. The zones will be drawn based on District activity that is improving the water budget of the shared resource for the area and on the premise that all groundwater users in the associated area should pay an equal share for the activity.

Suggested Edits

P. 1, 2nd paragraph, 2nd sentence: Suggestion partially accepted and memo will be revised to read: "Although the District is not aware of any specific problems with the existing Zone of Benefit designations, the District has received requests for exemption and recognizes that it is important for the District to periodically undertake…"

P. 1, 4th paragraph, 3rd sentence: "Unless adjacent bedrock areas and areas that are hydraulically upgradient from the District's recharge areas are receiving District water supply, it will be assumed that the areas are not within the zone of benefit…"

Response: This suggested edit will not be incorporated. Groundwater level improvements from recharge areas can transmit upgradient of the recharge areas.

P. 3, 3rd paragraph, 4th bullet: "Use groundwater data and groundwater flow models to ~~demonstrate~~ assess the benefit of District activities."

Response: The bullet will be changed to "Use groundwater data and groundwater flow models to *assess where the benefit of District activities can be demonstrated.*"

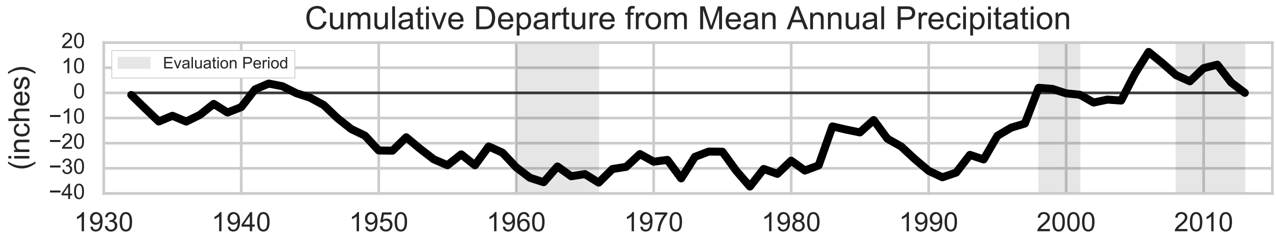
P. 3 add paragraph: "The Study will also consider non-District import of water supply by groundwater users (which decreases their use of groundwater), and recharge conditions and activities conducted by groundwater users."

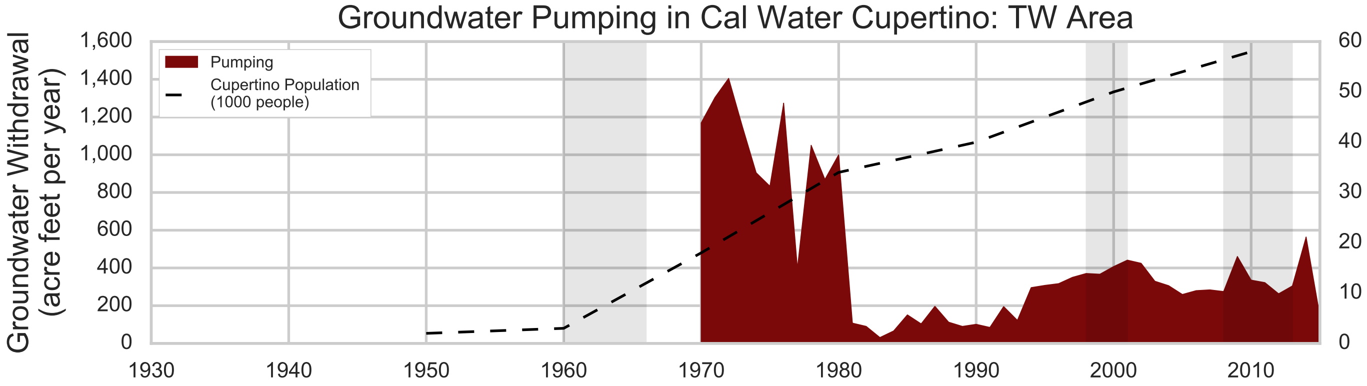
Response: The study is considering non-District supplies to ensure observed groundwater improvements can be assigned to District activities as stated in the response to comment 2a. However, zones of benefit will be based on where benefits from District activities can be demonstrated only. Since this introduction describes the general basis for the zones, this detail will not be added.

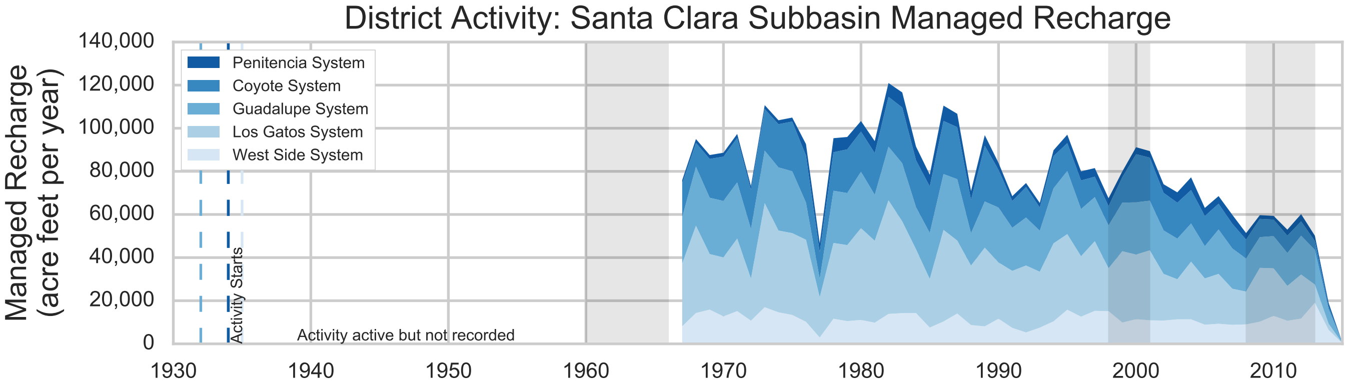
Appendix C

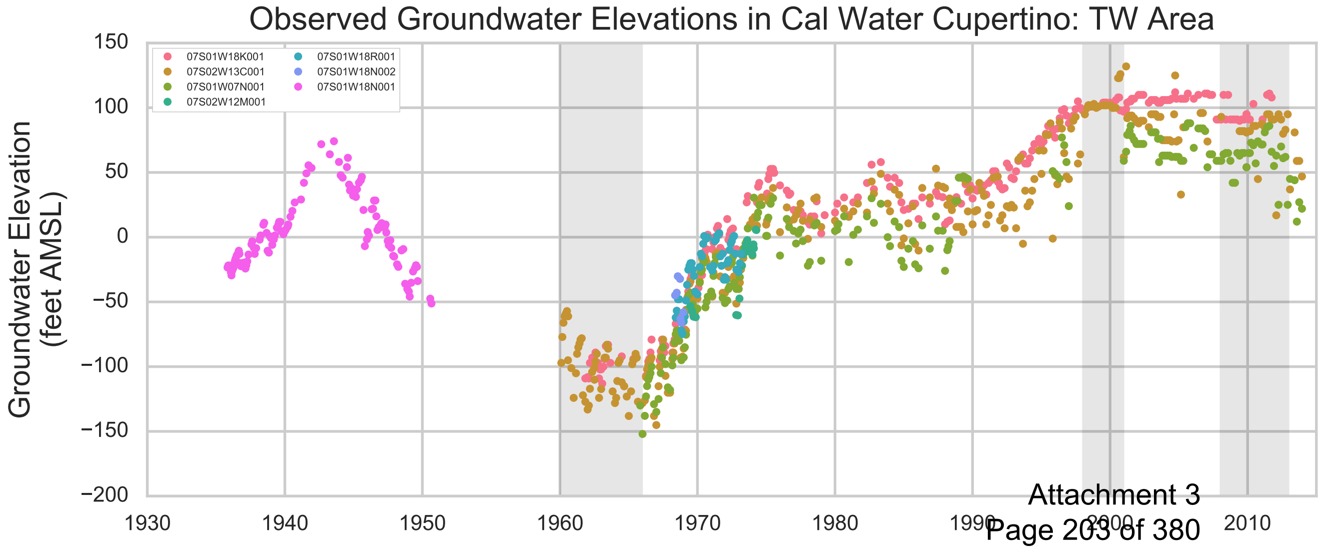
Groundwater Level Trends in Monitoring Wells to Evaluate Benefits from Managed Aquifer Recharge in Santa Clara Subbasin

Pumping Area: Cal Water Cupertino: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells


Cumulative Departure from Mean Annual Precipitation

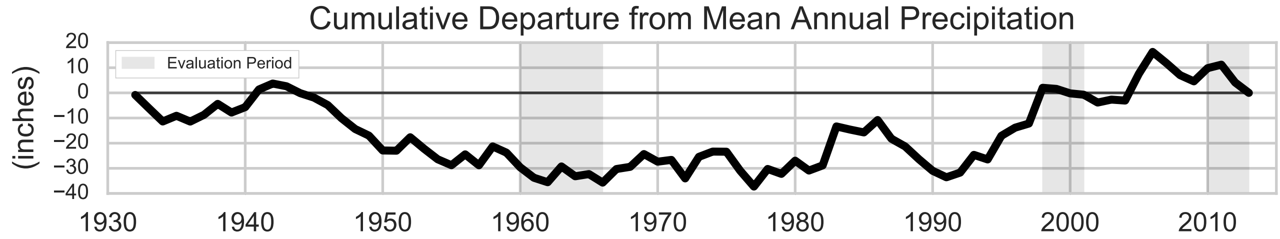

Groundwater Pumping in Cal Water Cupertino: TW Area

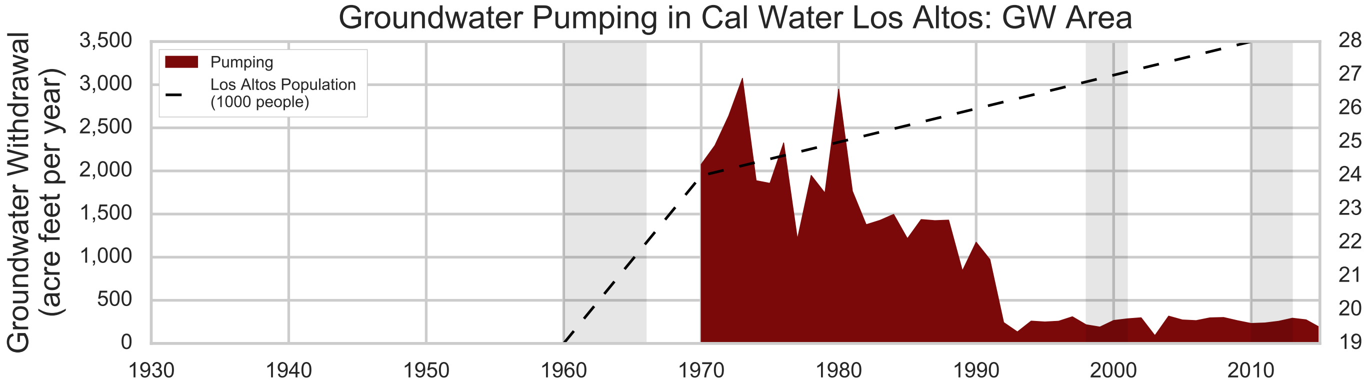

District Activity: Santa Clara Subbasin Managed Recharge

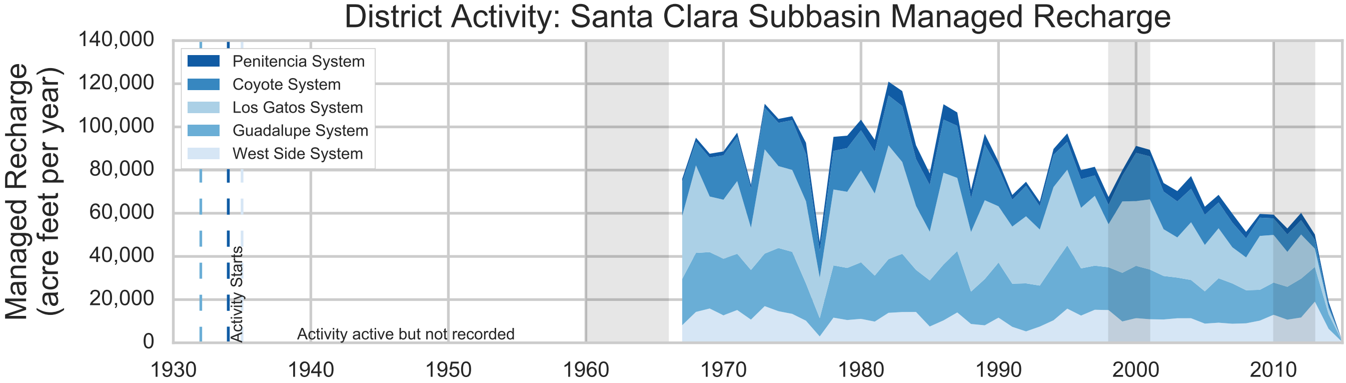

Observed Groundwater Elevations in Cal Water Cupertino: TW Area

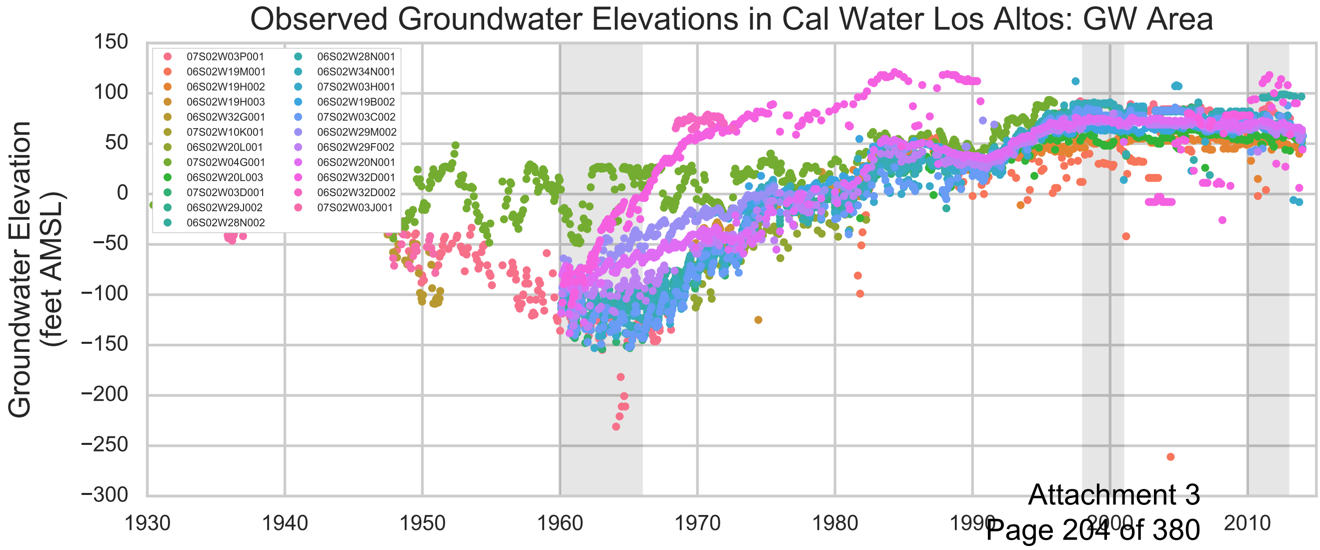
Pumping Area: Cal Water Los Altos: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT


Cumulative Departure from Mean Annual Precipitation


Groundwater Pumping in Cal Water Los Altos: GW Area

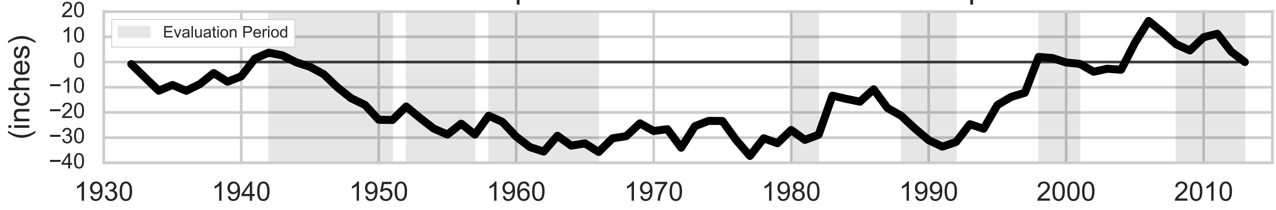

District Activity: Santa Clara Subbasin Managed Recharge


Observed Groundwater Elevations in Cal Water Los Altos: GW Area

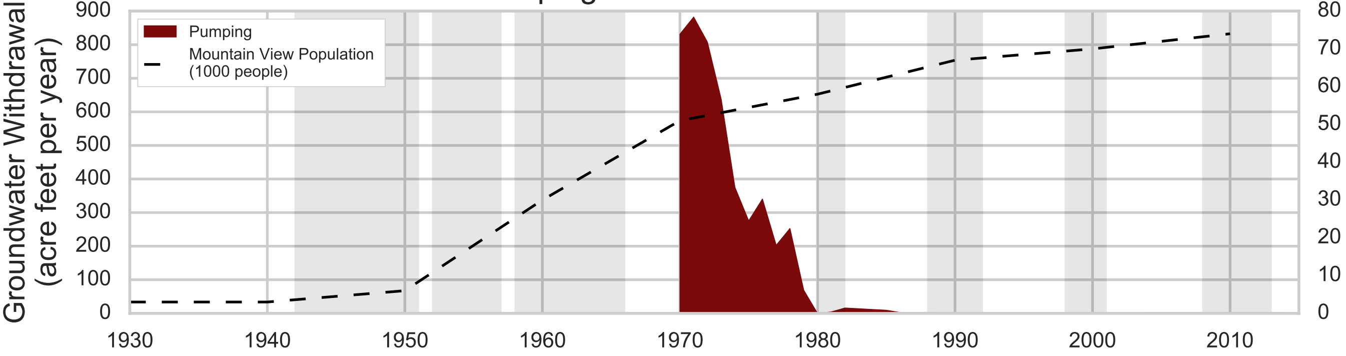
Pumping Area: Cal Water Mountain View: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT

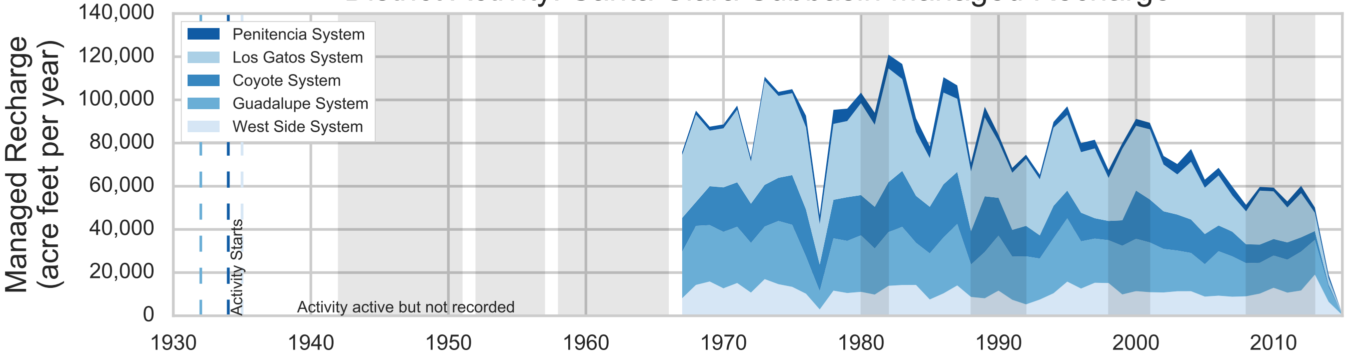
Cumulative Departure from Mean Annual Precipitation



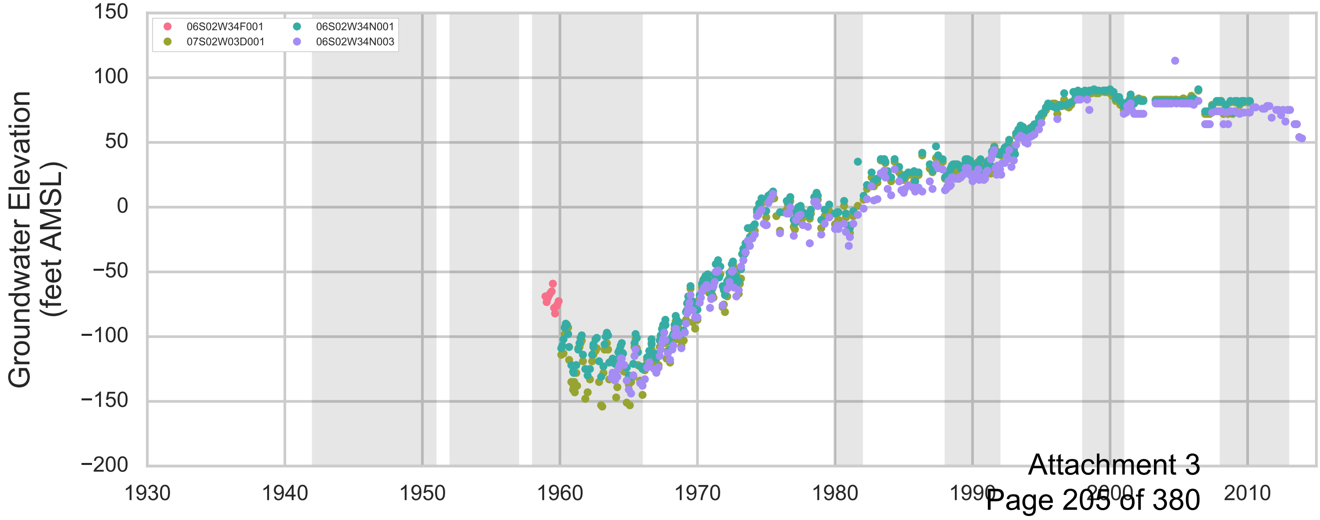
Groundwater Pumping in Cal Water Mountain View: GW Area



District Activity: Santa Clara Subbasin Managed Recharge



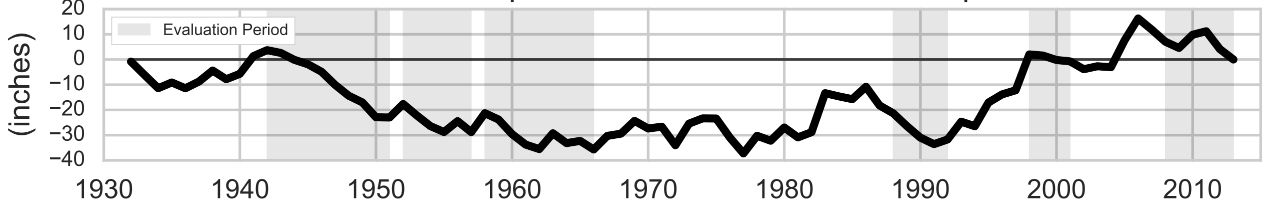
Observed Groundwater Elevations in Cal Water Mountain View: GW Area



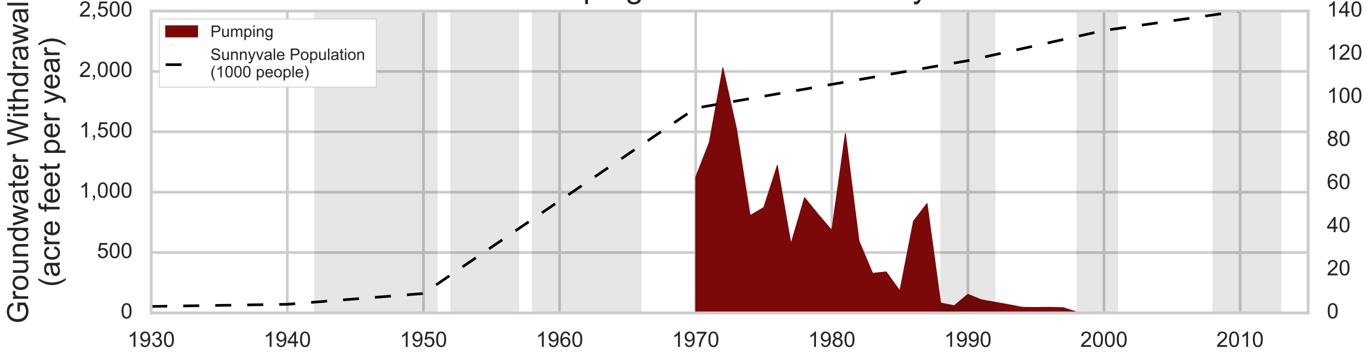
Pumping Area: Cal Water Sunnyvale: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT

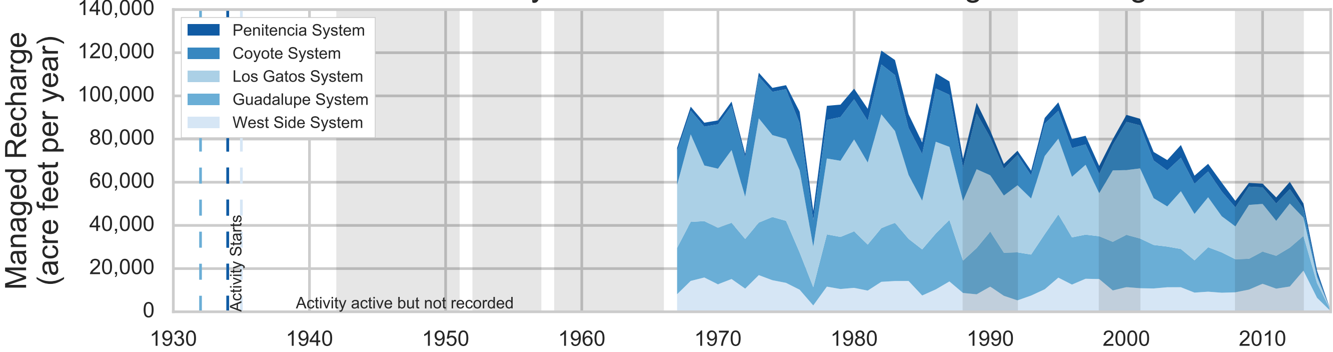
Cumulative Departure from Mean Annual Precipitation



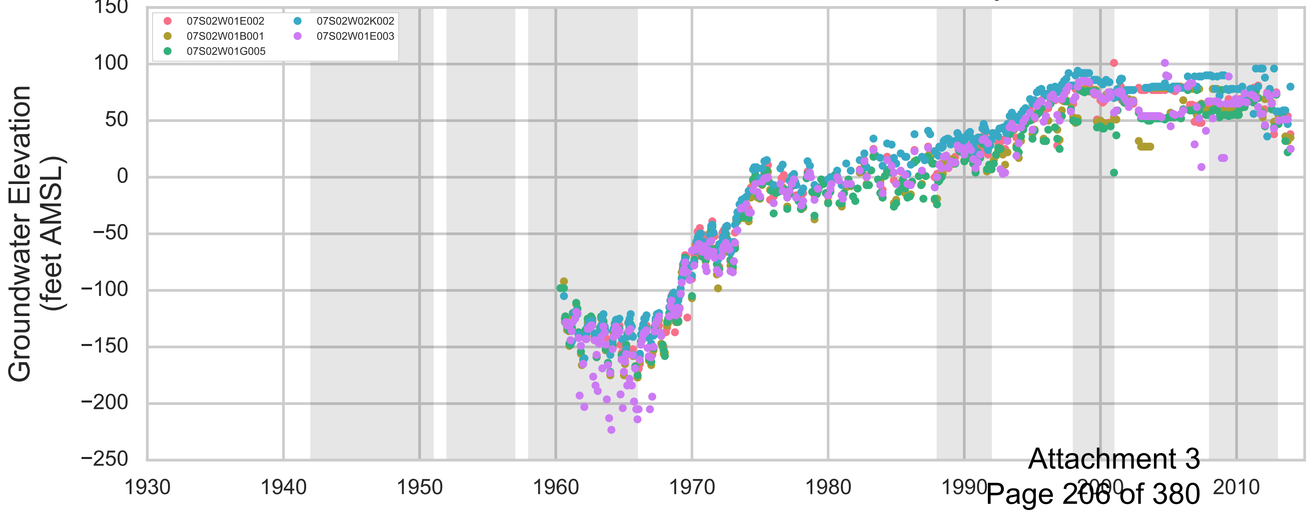
Groundwater Pumping in Cal Water Sunnyvale: GW Area



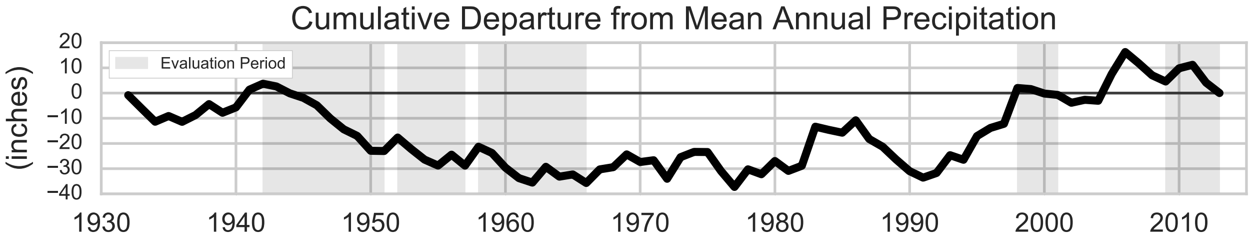
District Activity: Santa Clara Subbasin Managed Recharge

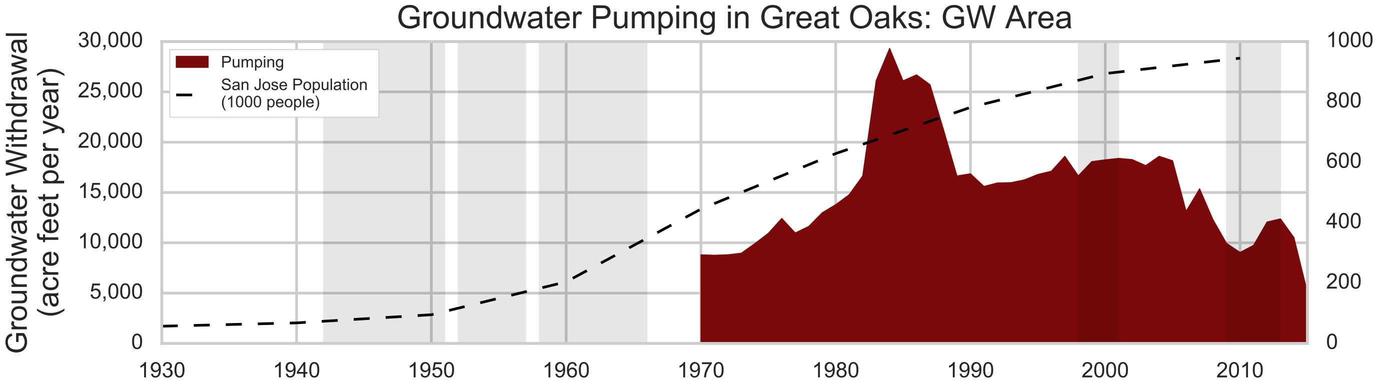


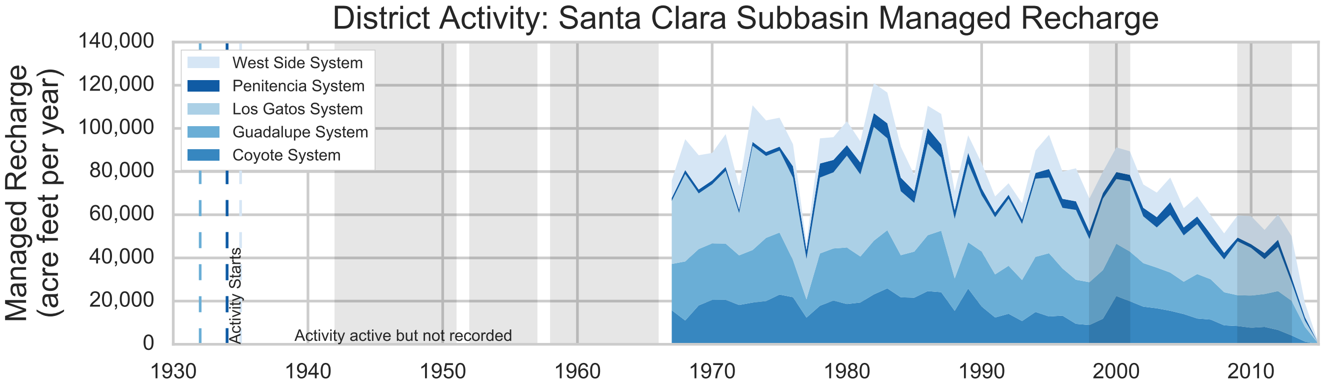
Observed Groundwater Elevations in Cal Water Sunnyvale: GW Area

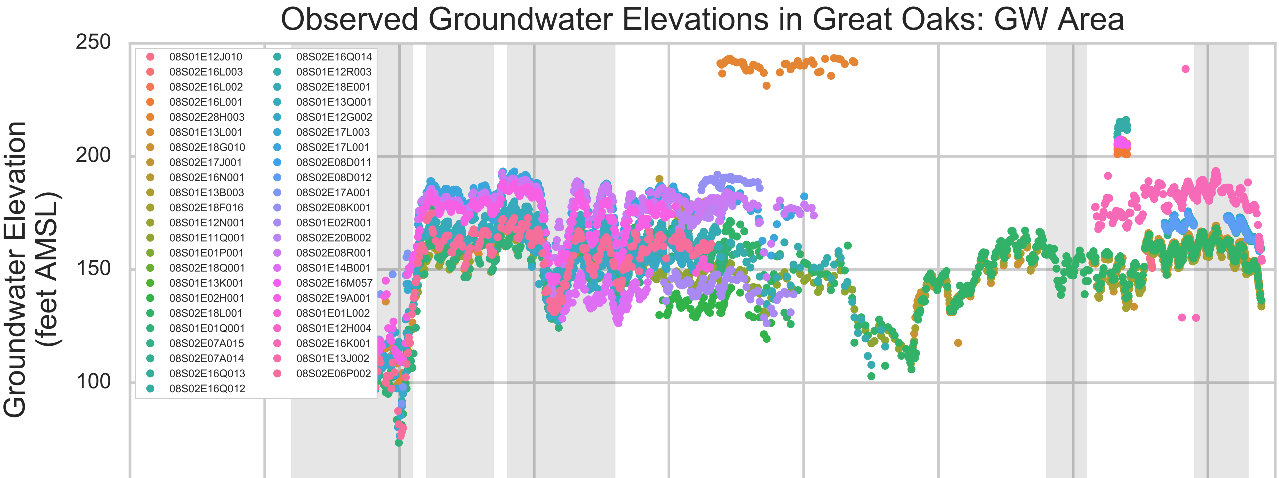


Pumping Area: Great Oaks: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells





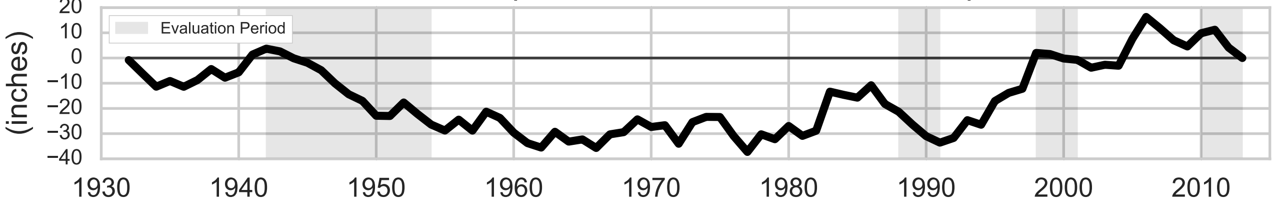




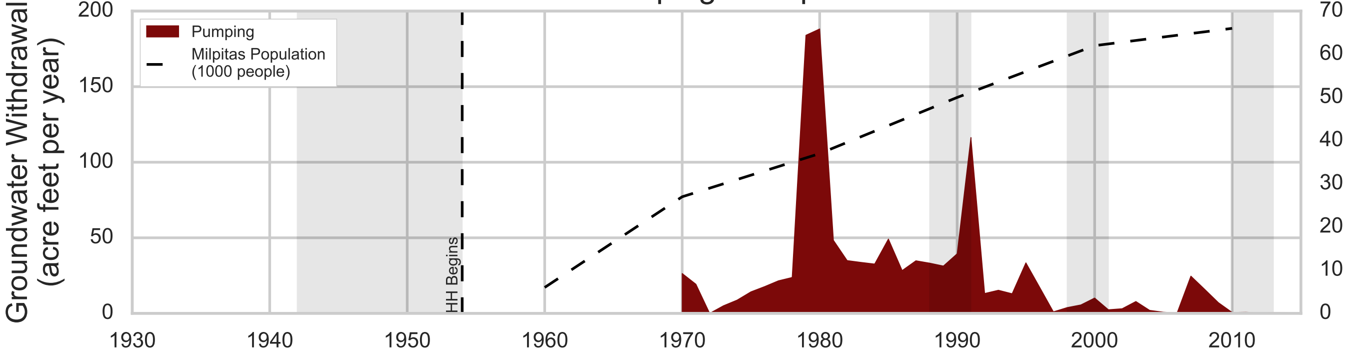
Pumping Area: Milpitas: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT

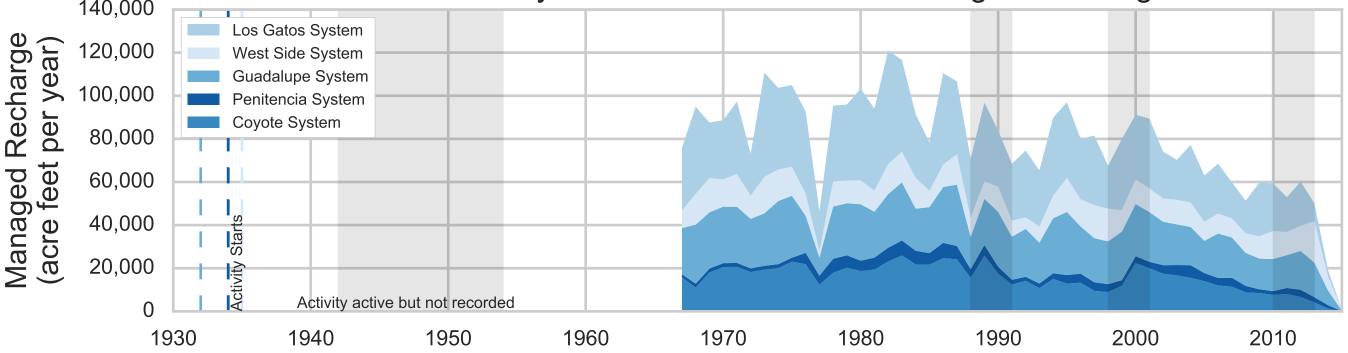
Cumulative Departure from Mean Annual Precipitation



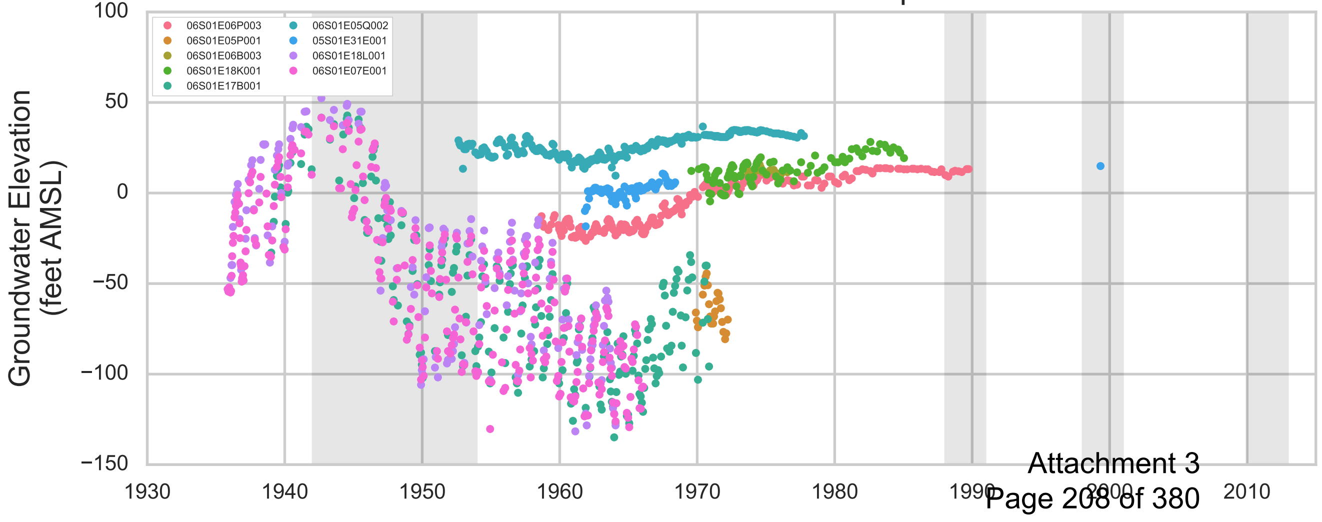
Groundwater Pumping in Milpitas: RWS Area



District Activity: Santa Clara Subbasin Managed Recharge



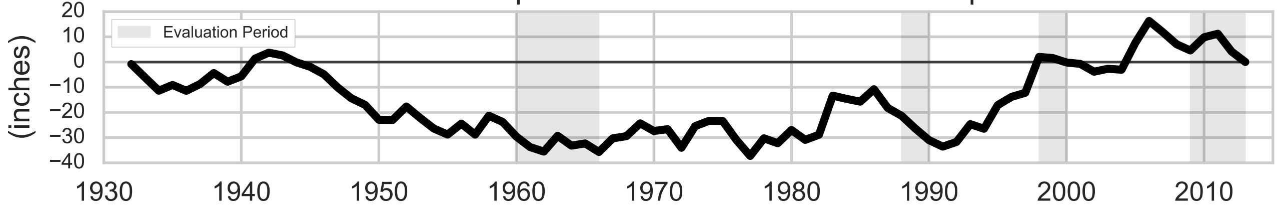
Observed Groundwater Elevations in Milpitas: RWS Area



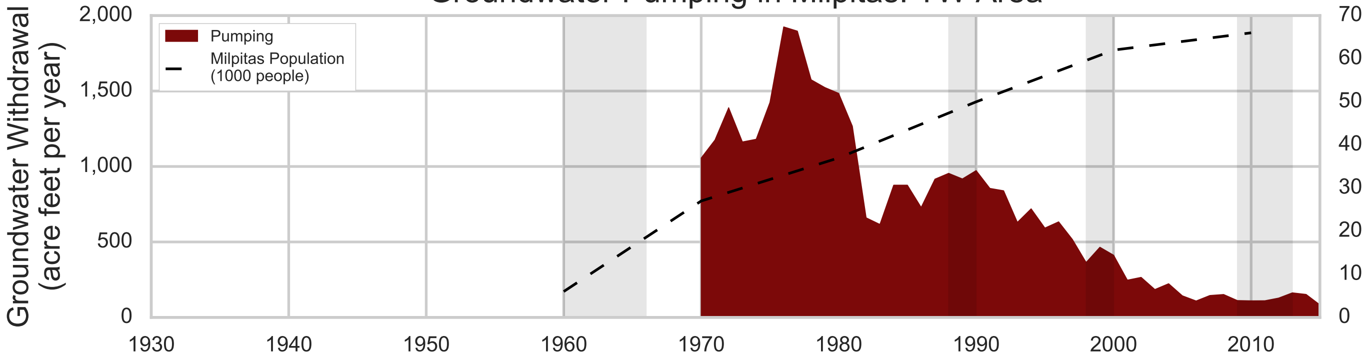
Pumping Area: Milpitas: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT

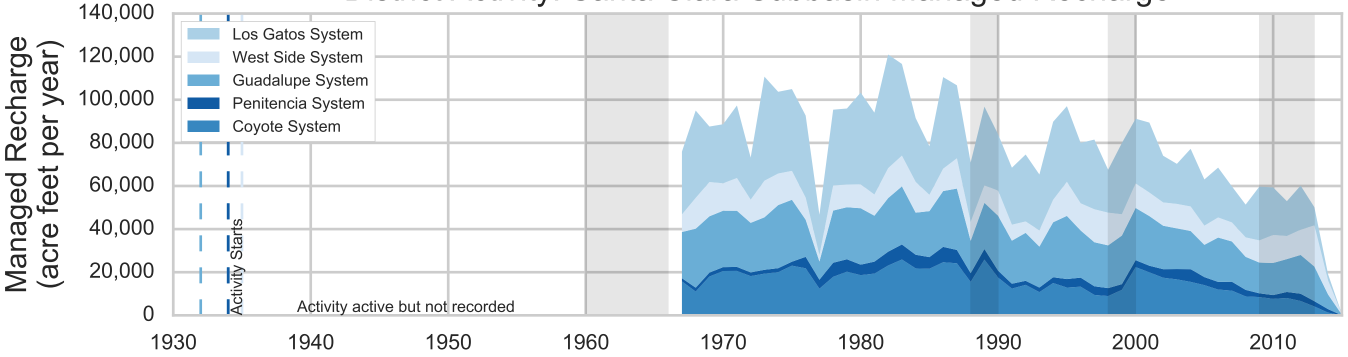
Cumulative Departure from Mean Annual Precipitation



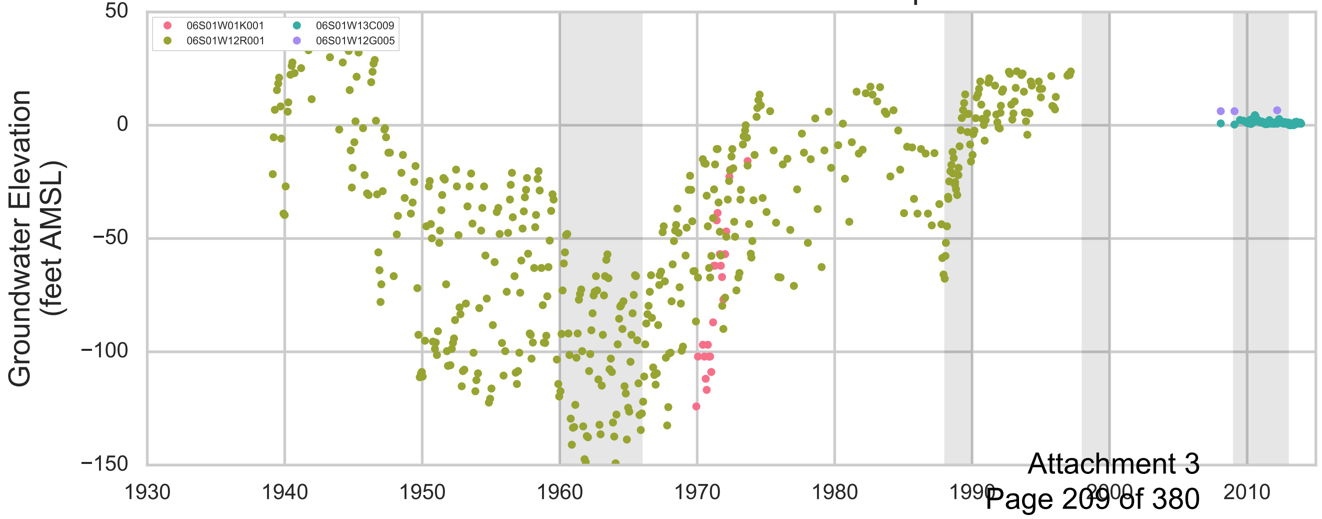
Groundwater Pumping in Milpitas: TW Area



District Activity: Santa Clara Subbasin Managed Recharge

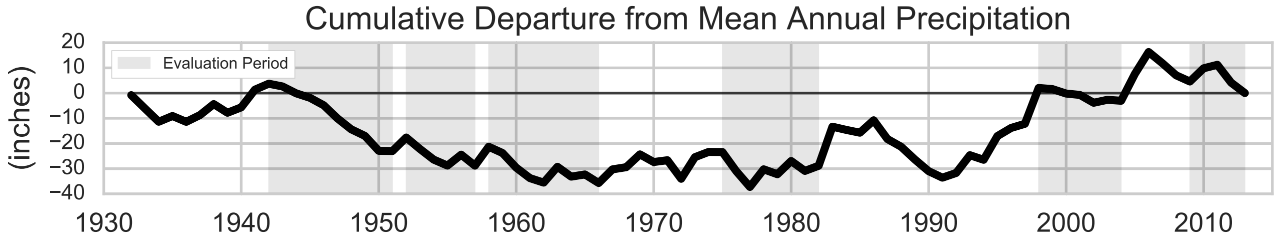


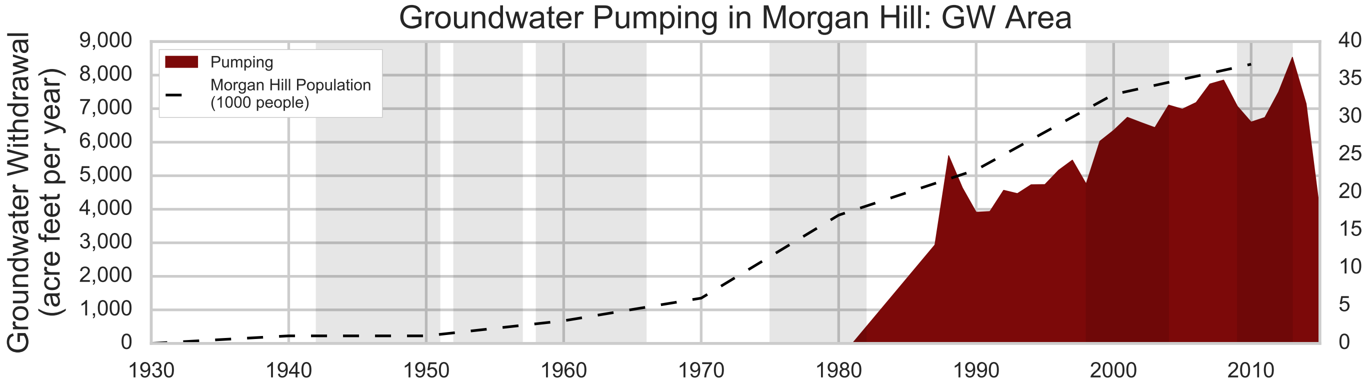
Observed Groundwater Elevations in Milpitas: TW Area

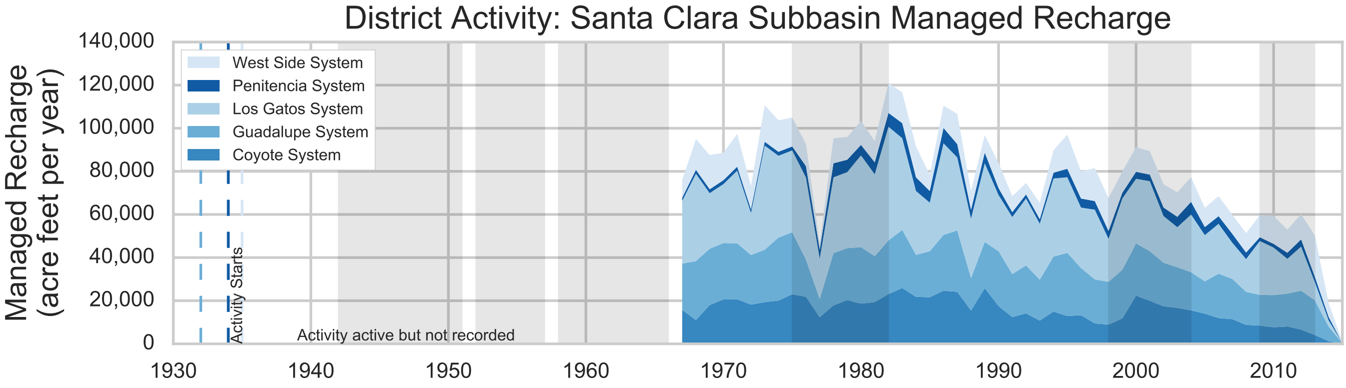


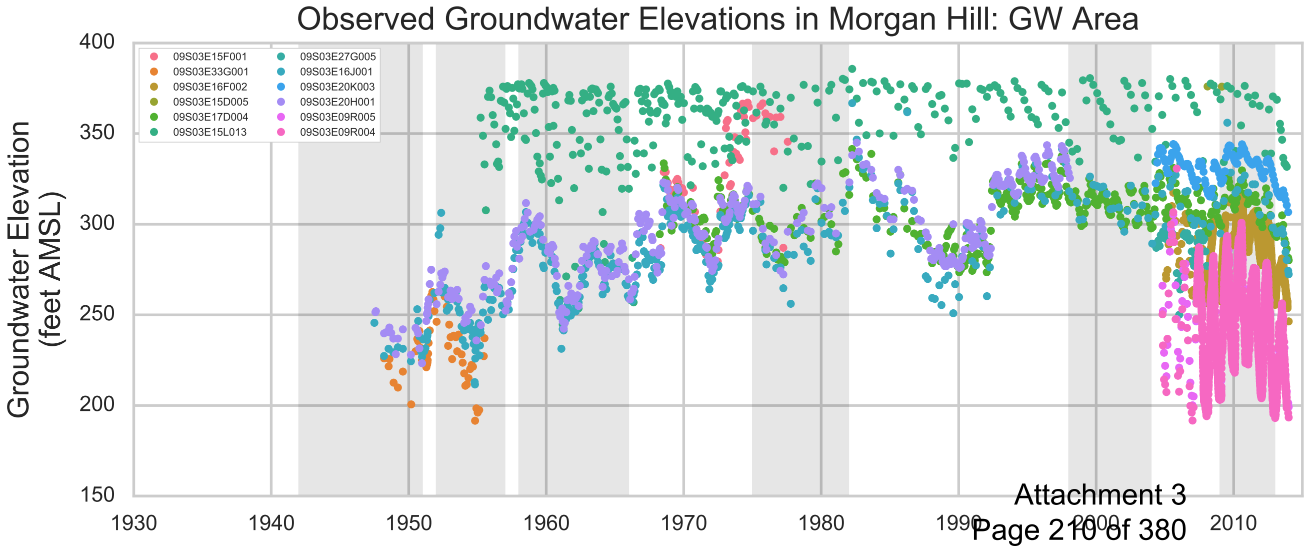
Pumping Area: Morgan Hill: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT


Cumulative Departure from Mean Annual Precipitation

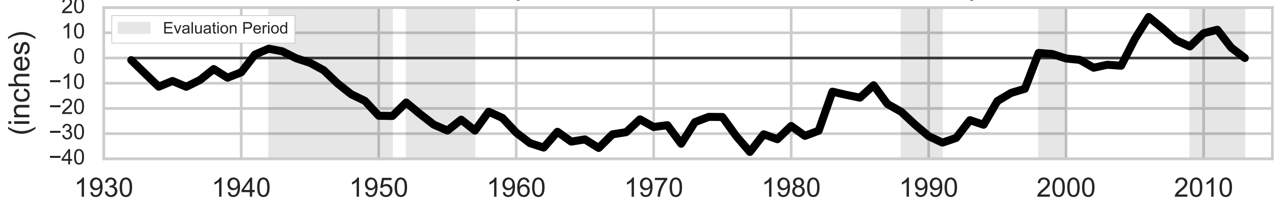

Groundwater Pumping in Morgan Hill: GW Area


District Activity: Santa Clara Subbasin Managed Recharge

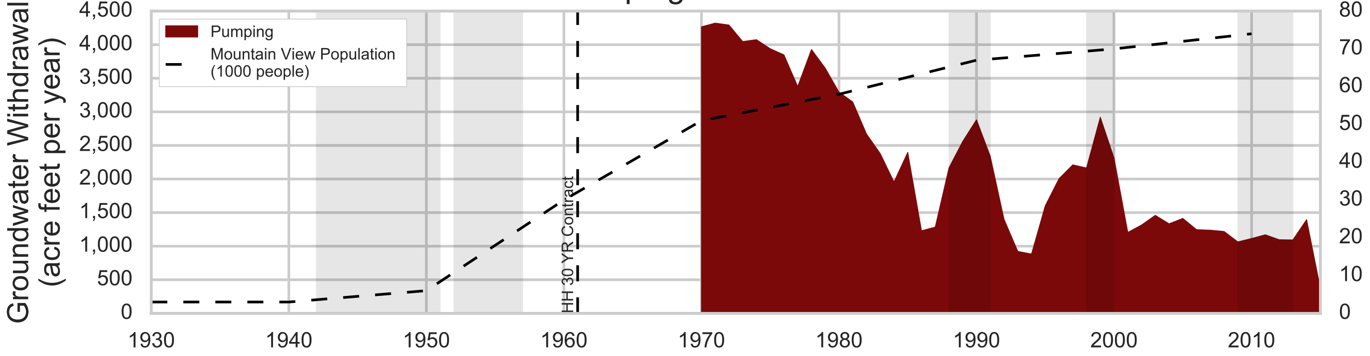

Observed Groundwater Elevations in Morgan Hill: GW Area

Pumping Area: Mountain View: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

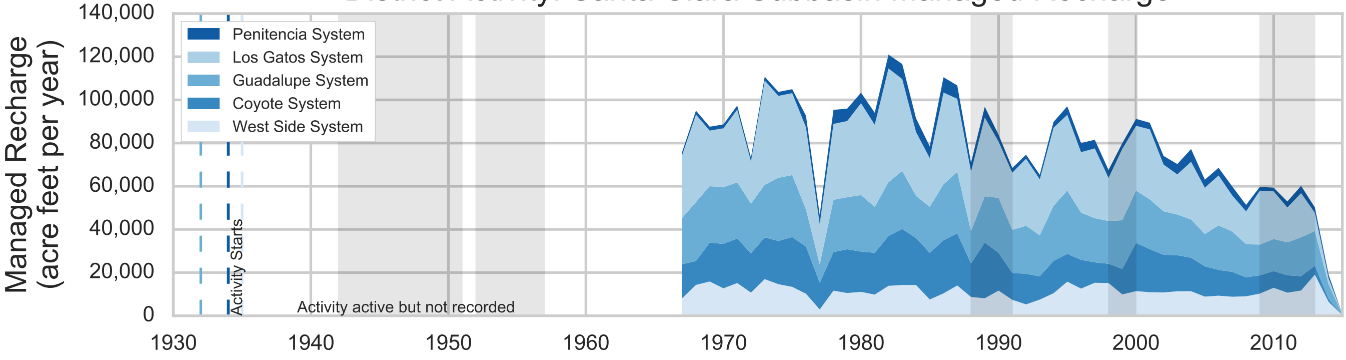
DRAFT



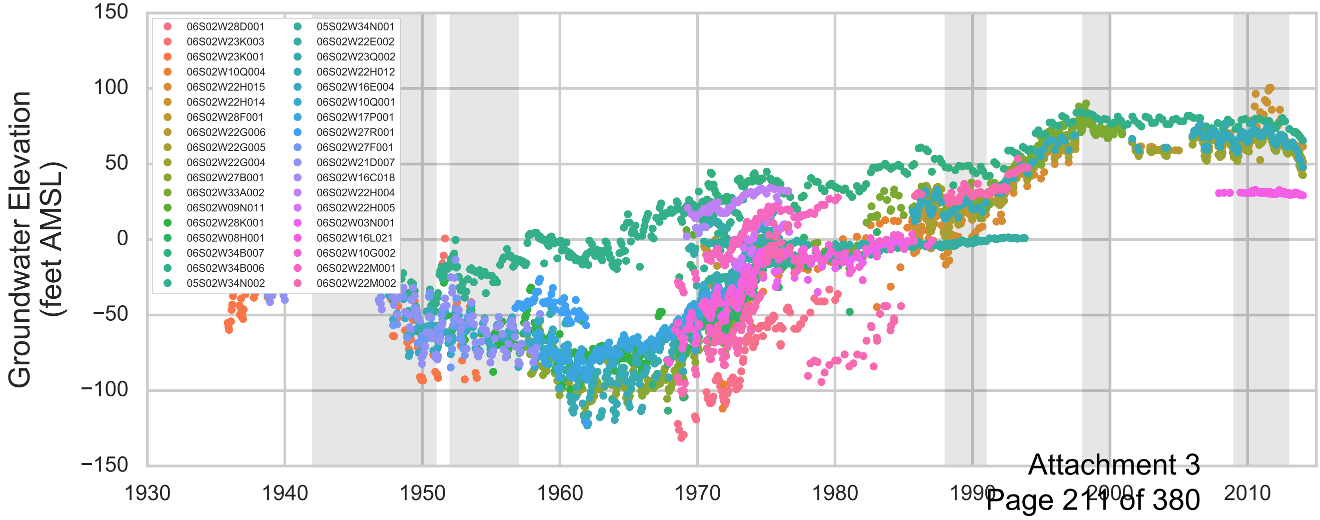
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in Mountain View: RWS Area



District Activity: Santa Clara Subbasin Managed Recharge

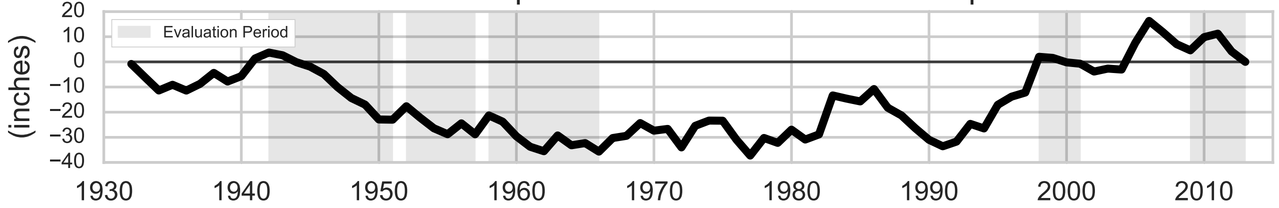


Observed Groundwater Elevations in Mountain View: RWS Area

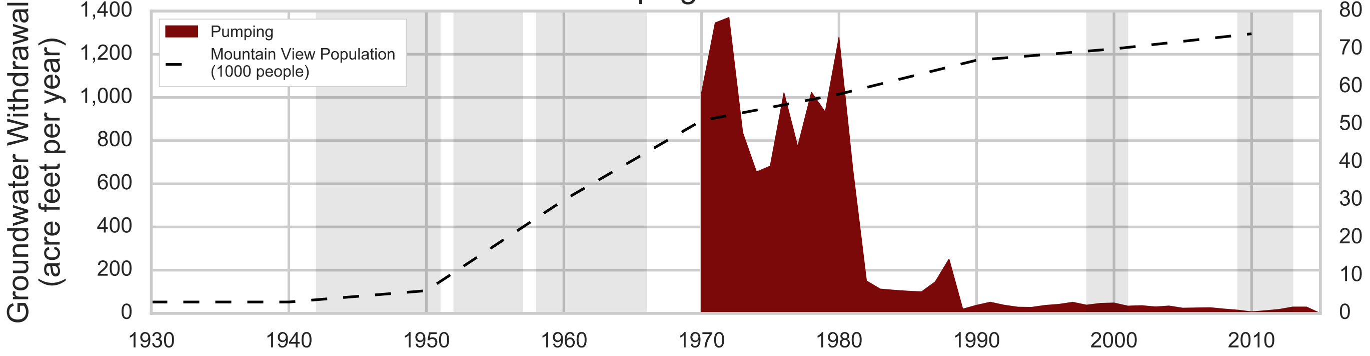
Pumping Area: Mountain View: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT

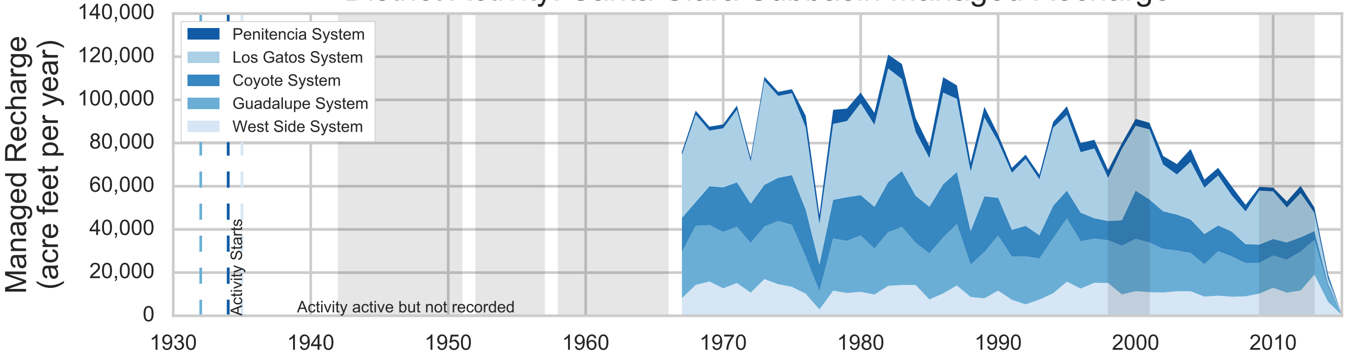
Cumulative Departure from Mean Annual Precipitation



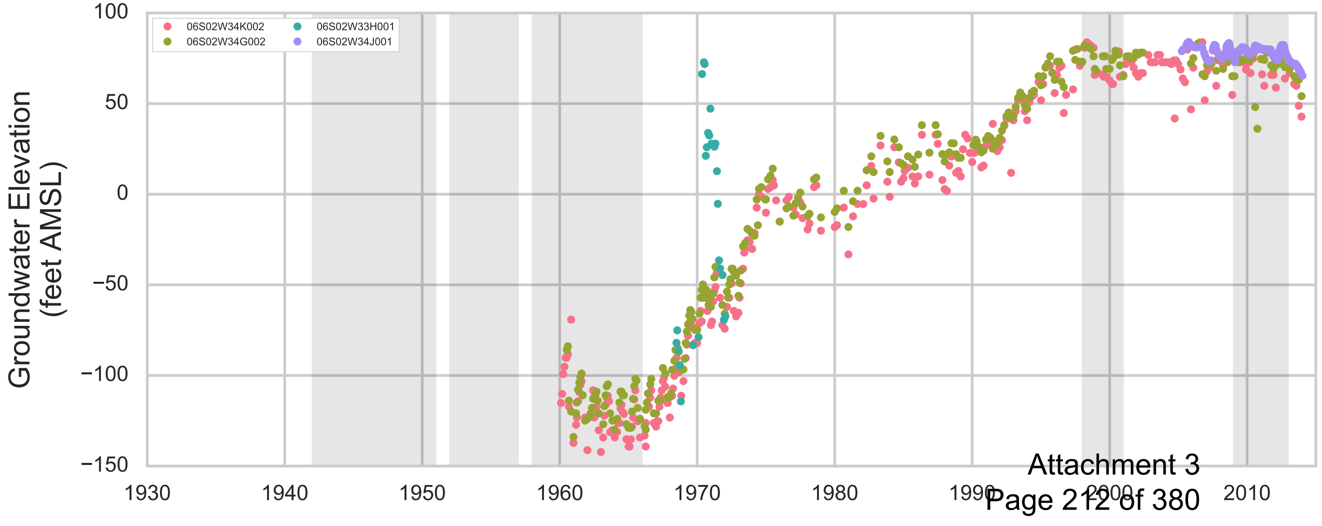
Groundwater Pumping in Mountain View: TW Area



District Activity: Santa Clara Subbasin Managed Recharge

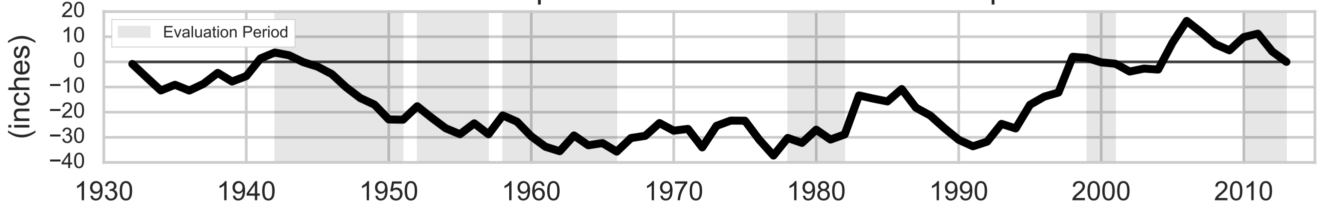


Observed Groundwater Elevations in Mountain View: TW Area

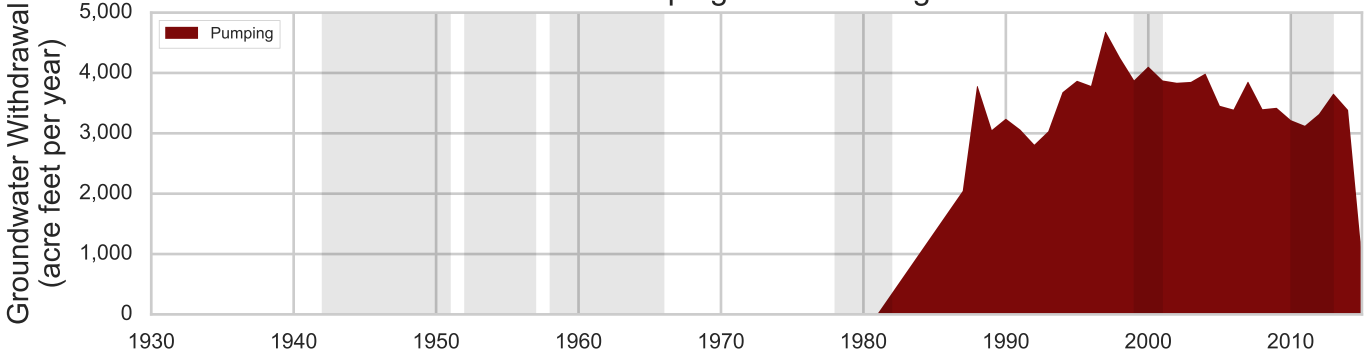


Pumping Area: North Morgan Hill:
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

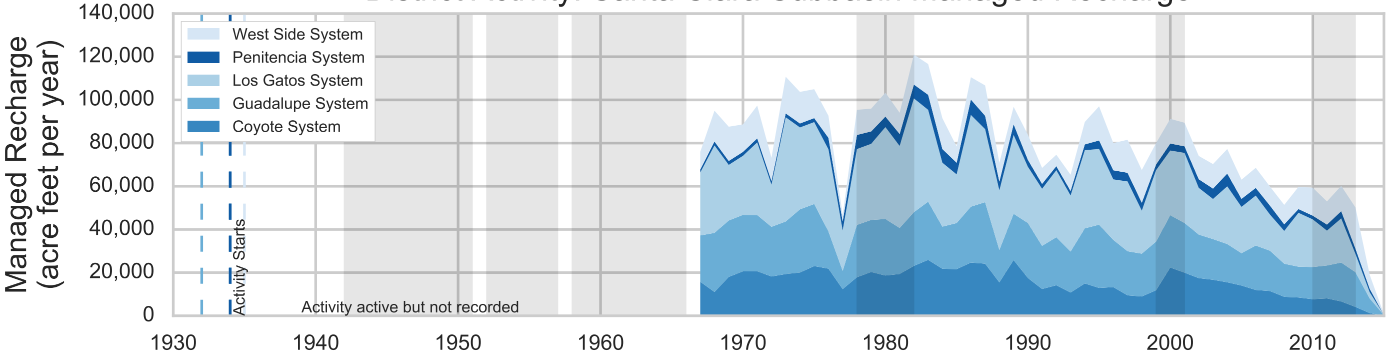
DRAFT



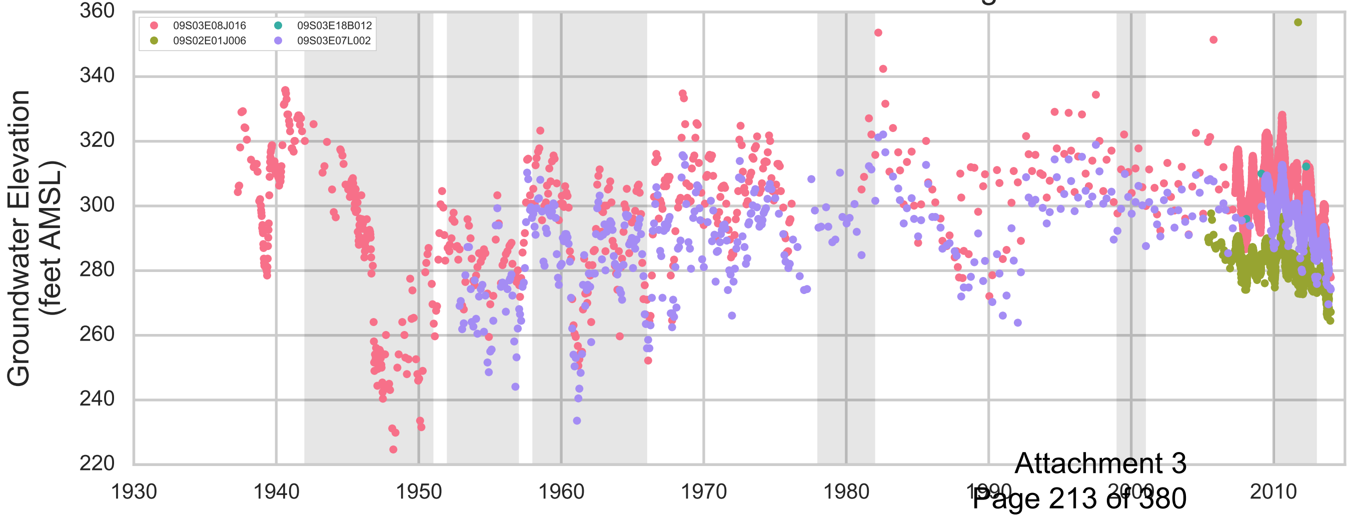
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in North Morgan Hill: Area



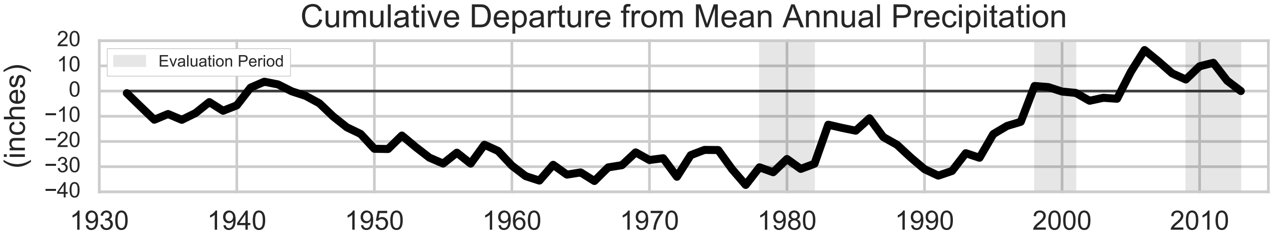
District Activity: Santa Clara Subbasin Managed Recharge

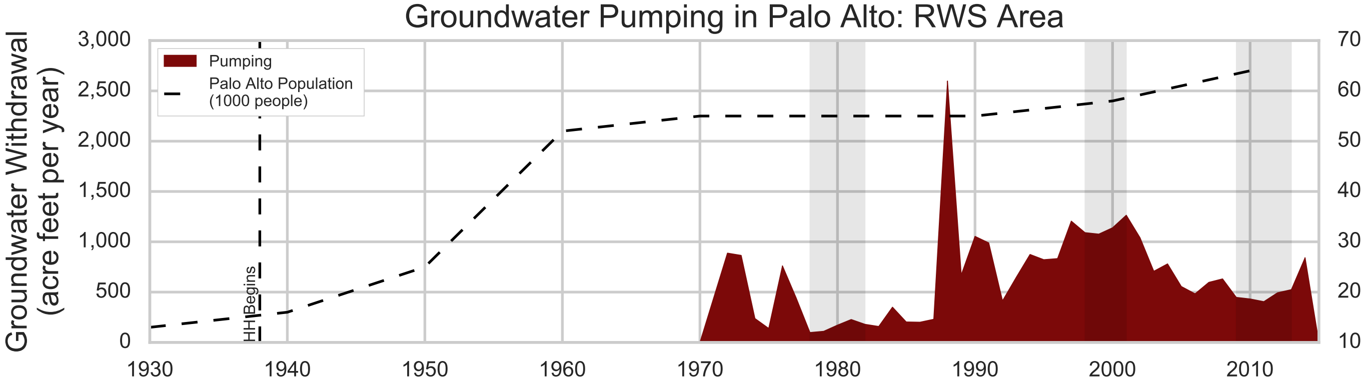


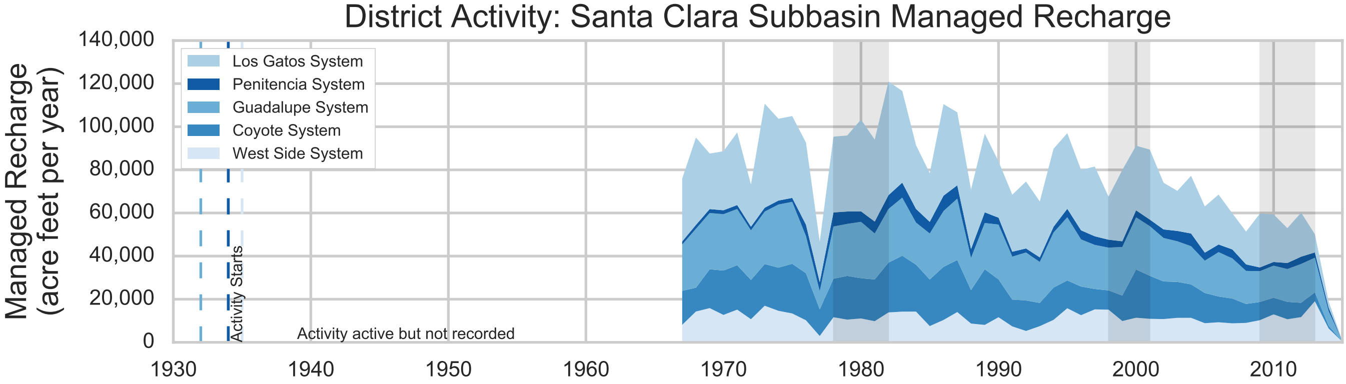
Observed Groundwater Elevations in North Morgan Hill: Area

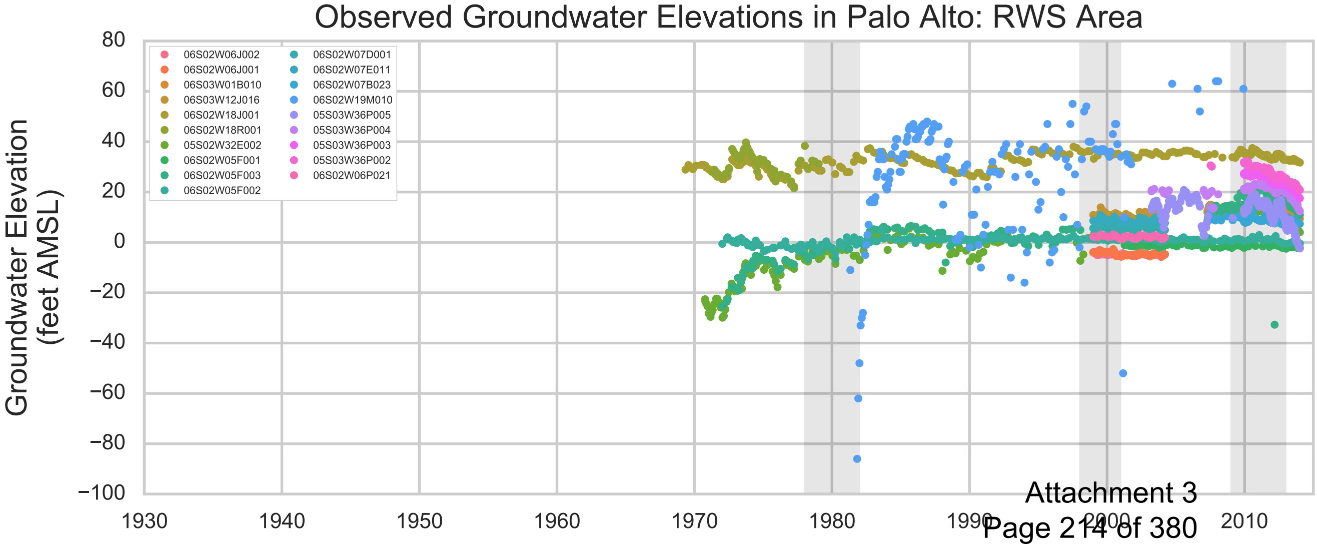
Pumping Area: Palo Alto: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT


Cumulative Departure from Mean Annual Precipitation

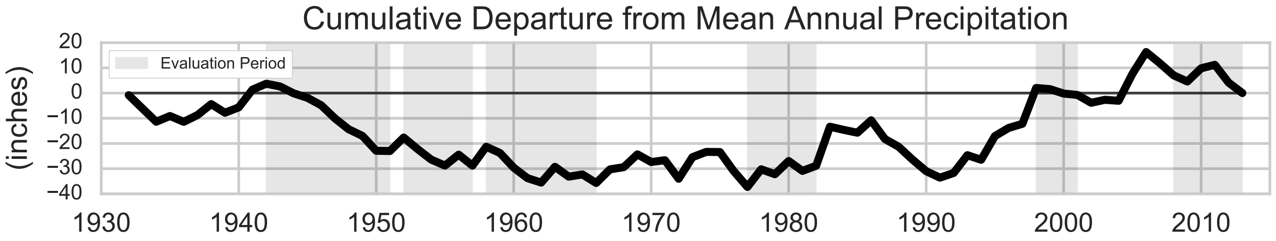

Groundwater Pumping in Palo Alto: RWS Area

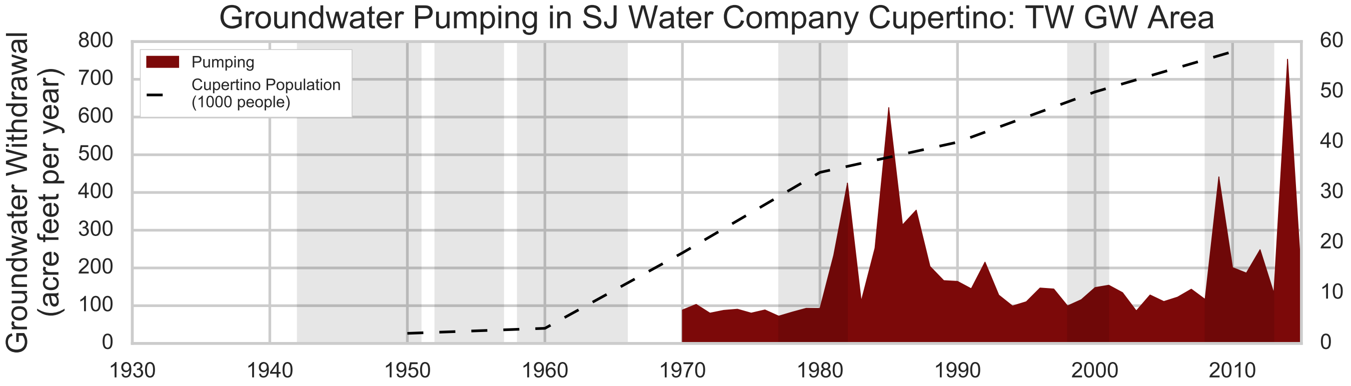

District Activity: Santa Clara Subbasin Managed Recharge

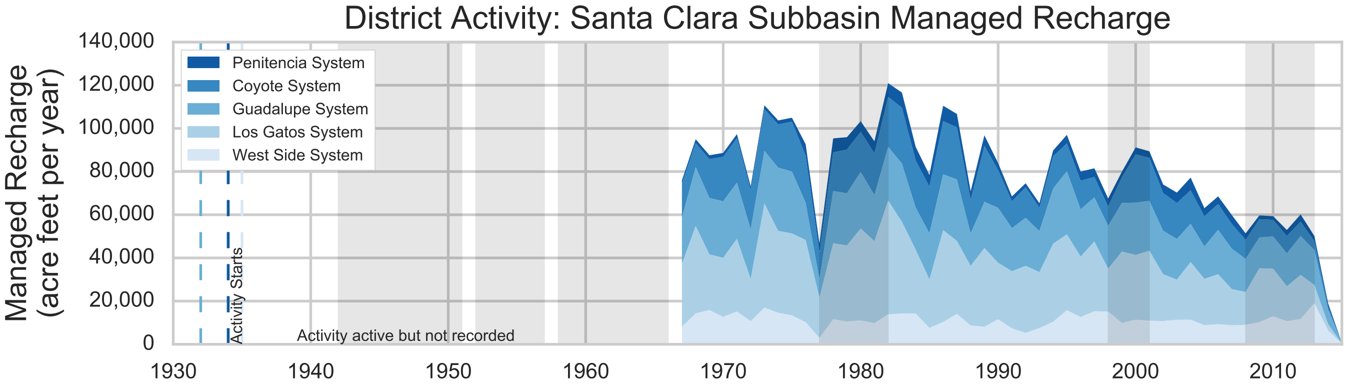

Observed Groundwater Elevations in Palo Alto: RWS Area

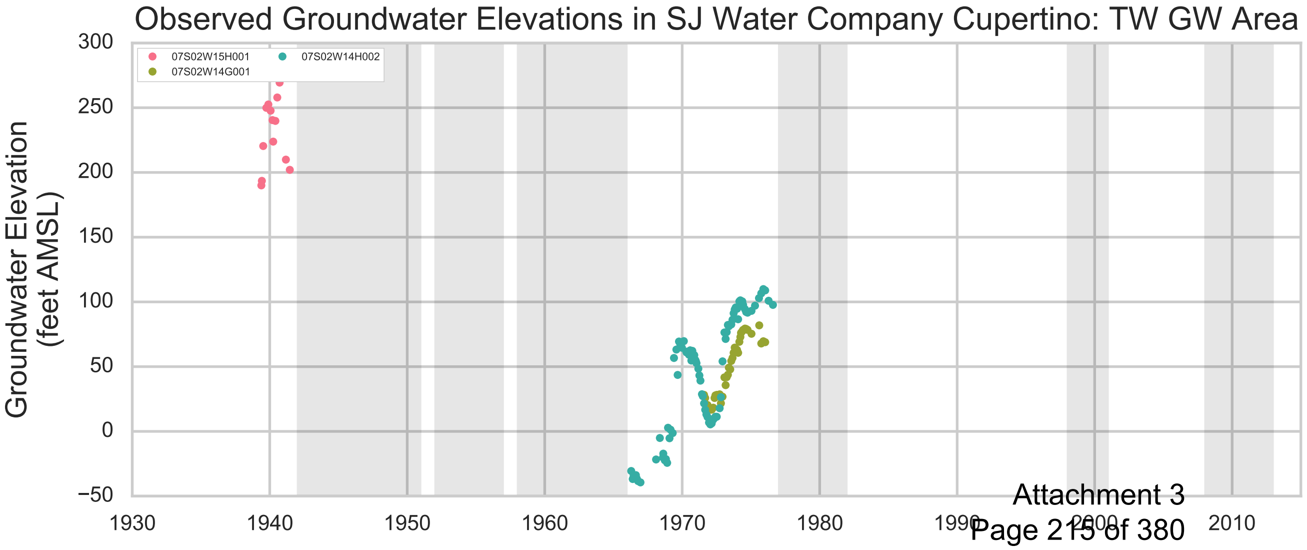
Pumping Area: SJ Water Company Cupertino: TW GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT


Cumulative Departure from Mean Annual Precipitation

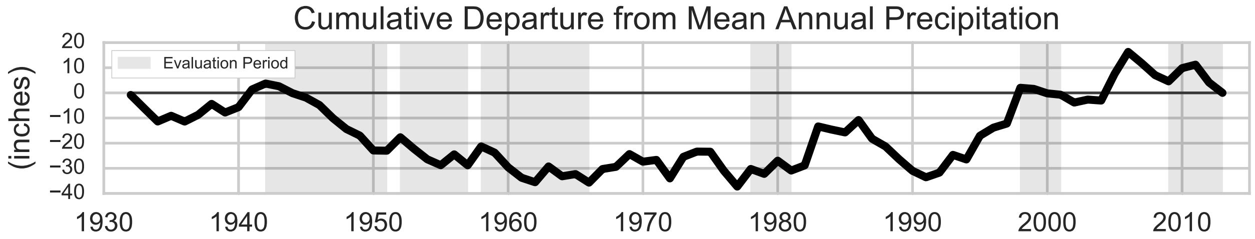

Groundwater Pumping in SJ Water Company Cupertino: TW GW Area

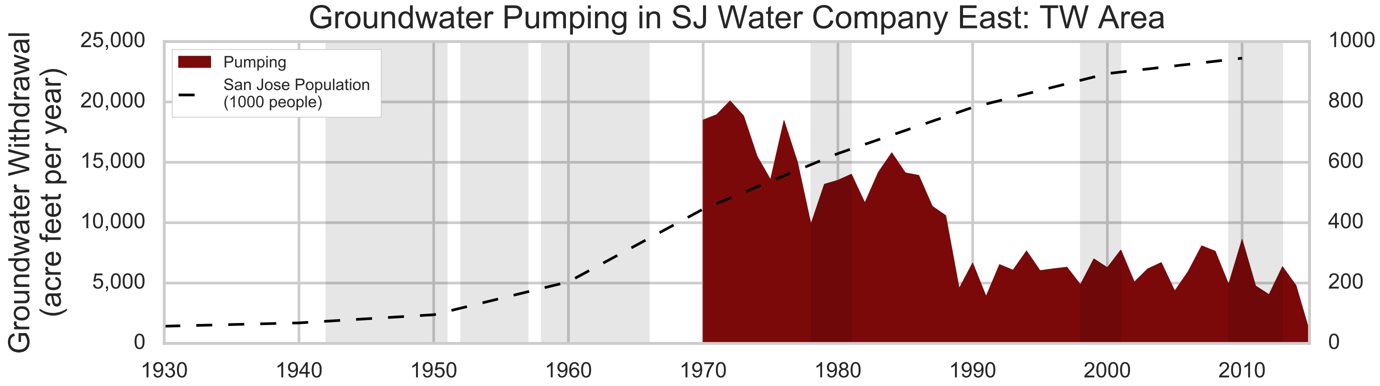

District Activity: Santa Clara Subbasin Managed Recharge

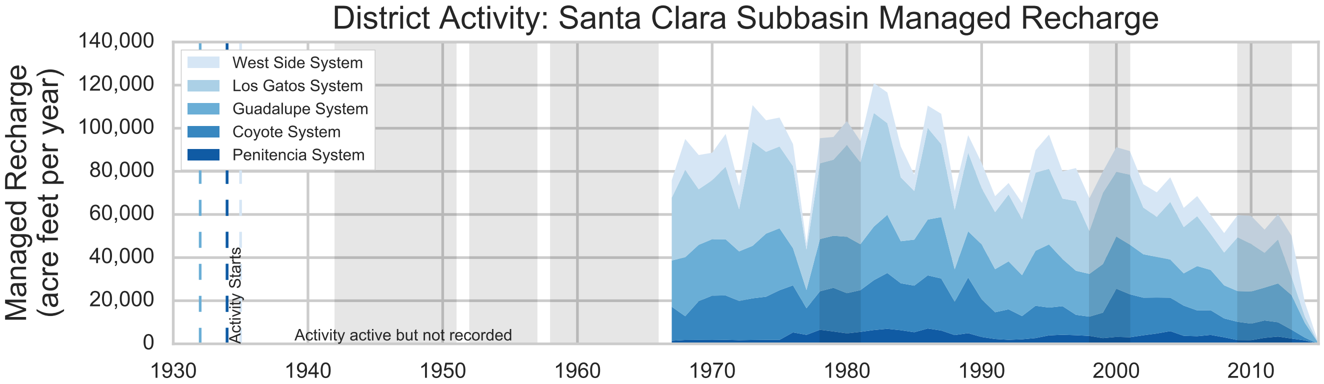

Observed Groundwater Elevations in SJ Water Company Cupertino: TW GW Area

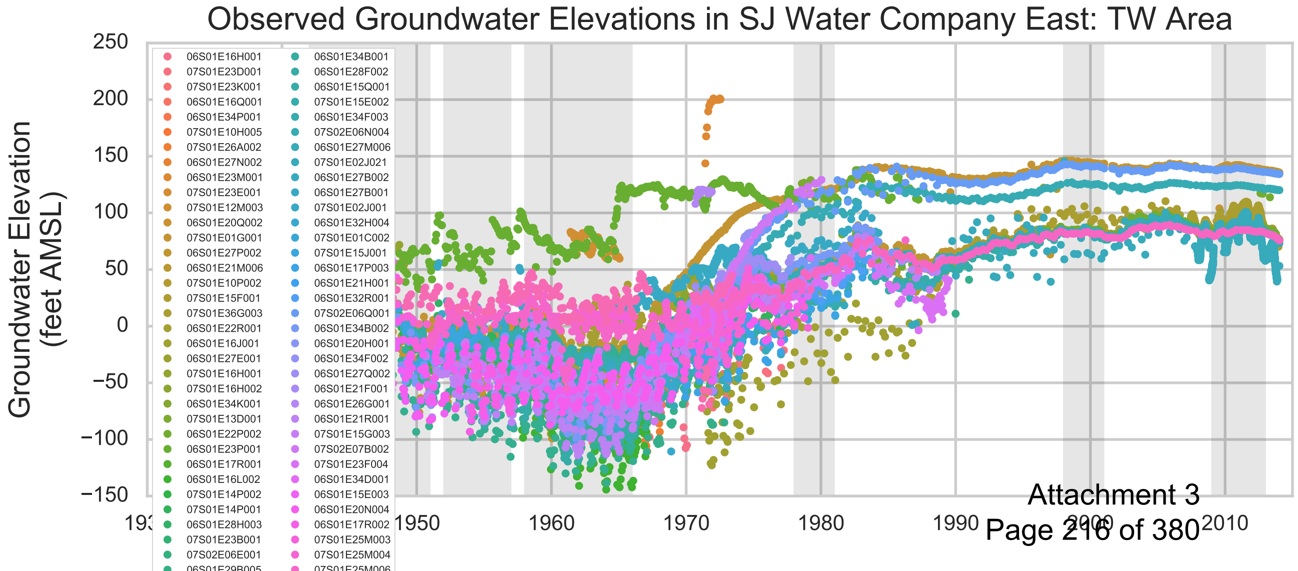
Pumping Area: SJ Water Company East: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT





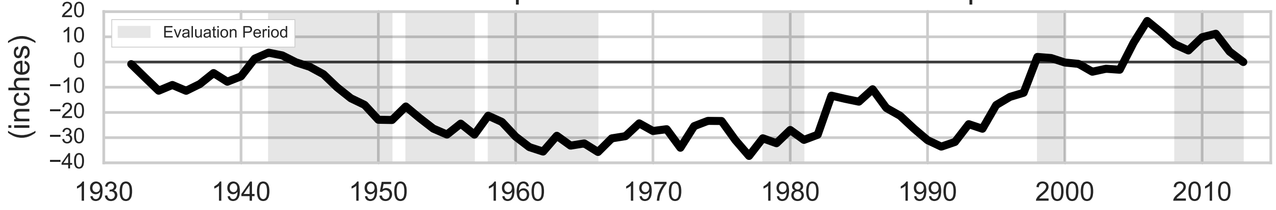




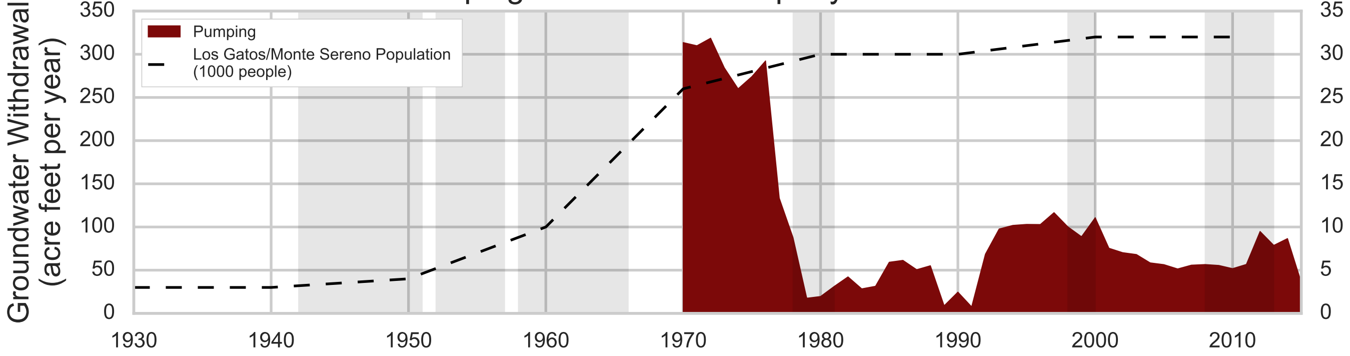
Pumping Area: SJ Water Company Los Gatos: Local SW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT

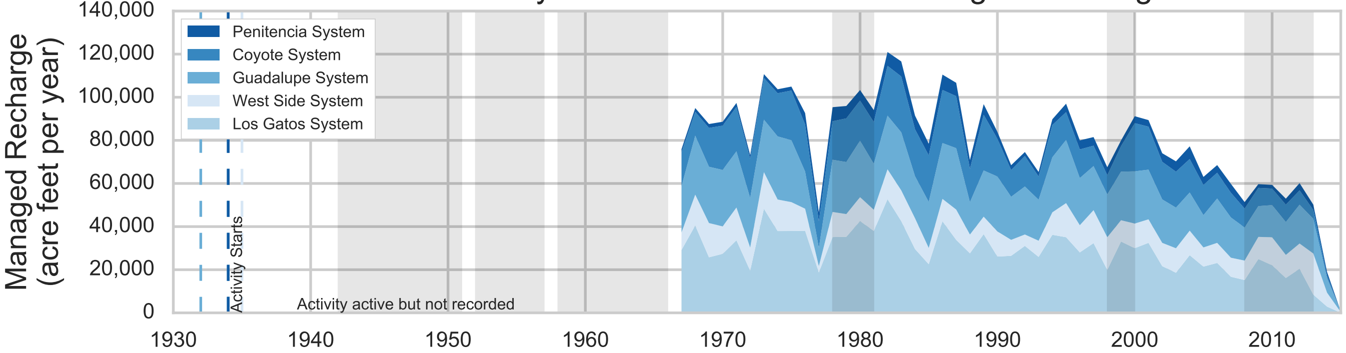
Cumulative Departure from Mean Annual Precipitation



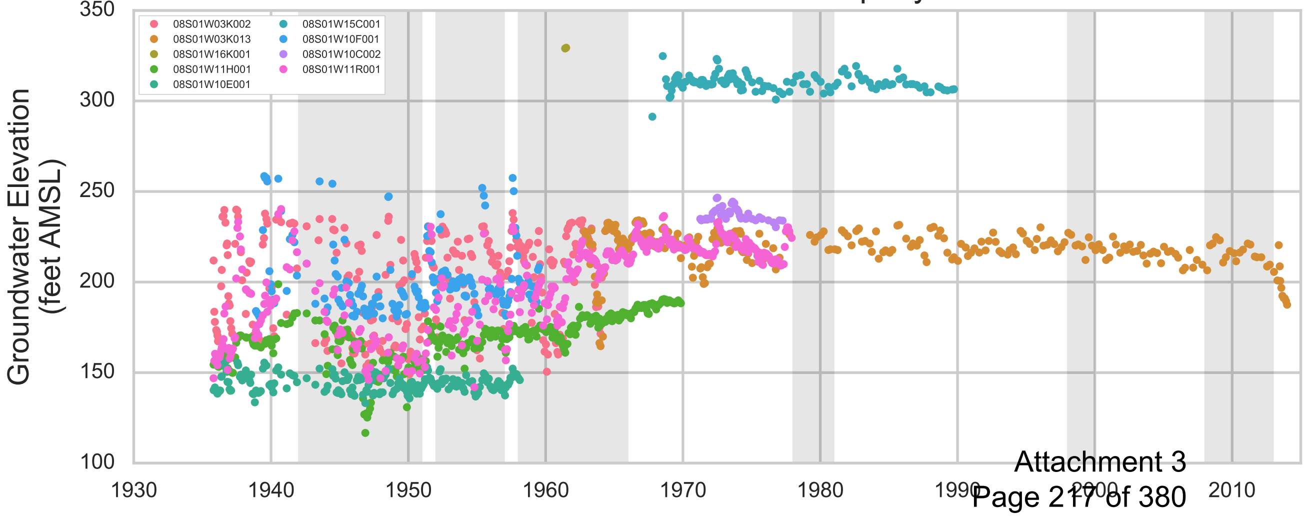
Groundwater Pumping in SJ Water Company Los Gatos: Local SW Area



District Activity: Santa Clara Subbasin Managed Recharge



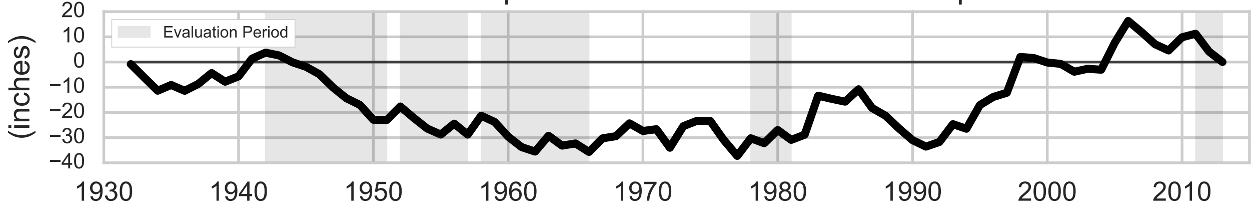
Observed Groundwater Elevations in SJ Water Company Los Gatos: Local SW Area



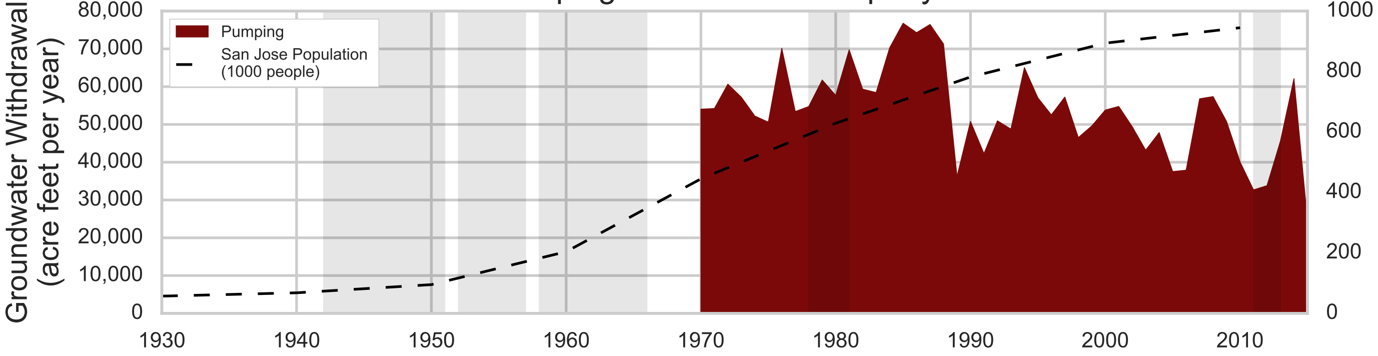
Pumping Area: SJ Water Company North: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

DRAFT

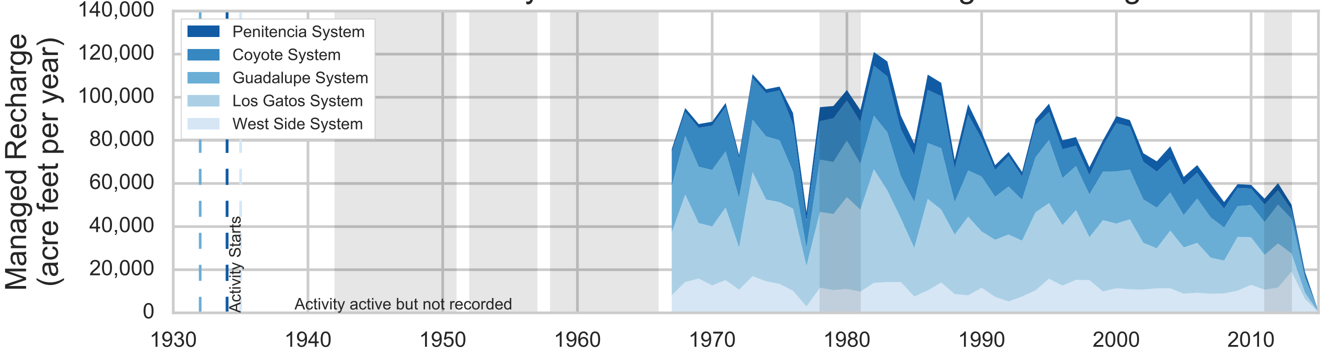
Cumulative Departure from Mean Annual Precipitation



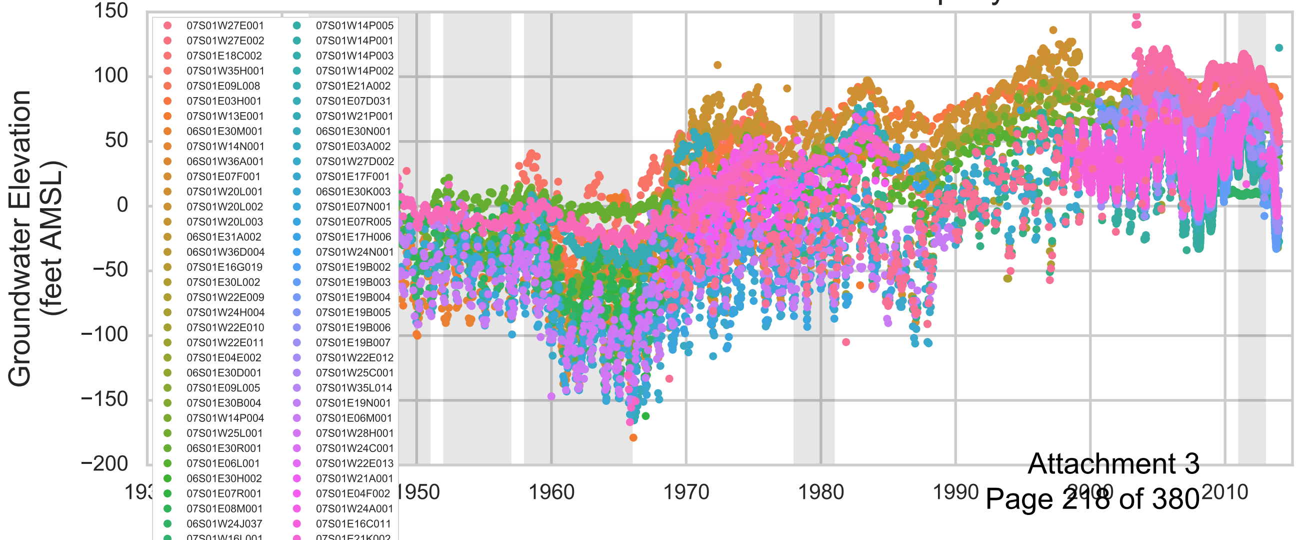
Groundwater Pumping in SJ Water Company North: GW Area



District Activity: Santa Clara Subbasin Managed Recharge

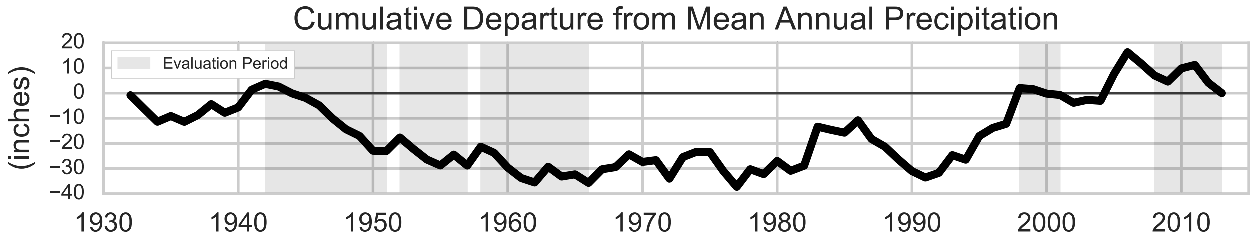


Observed Groundwater Elevations in SJ Water Company North: GW Area

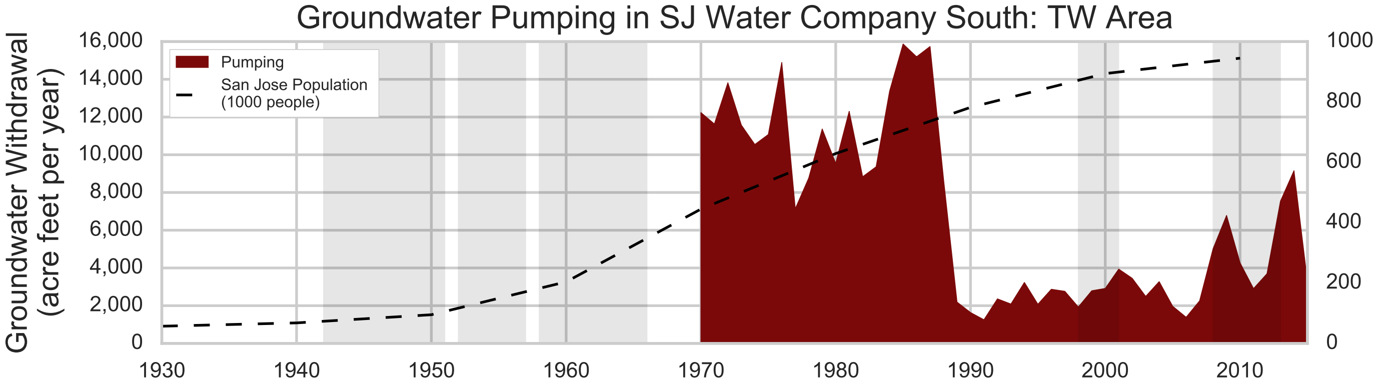


Pumping Area: SJ Water Company South: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

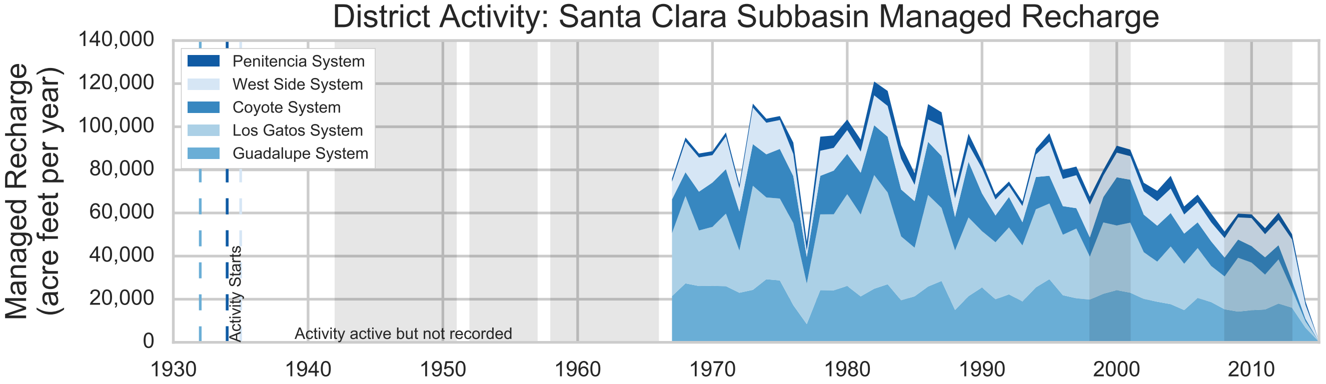
DRAFT



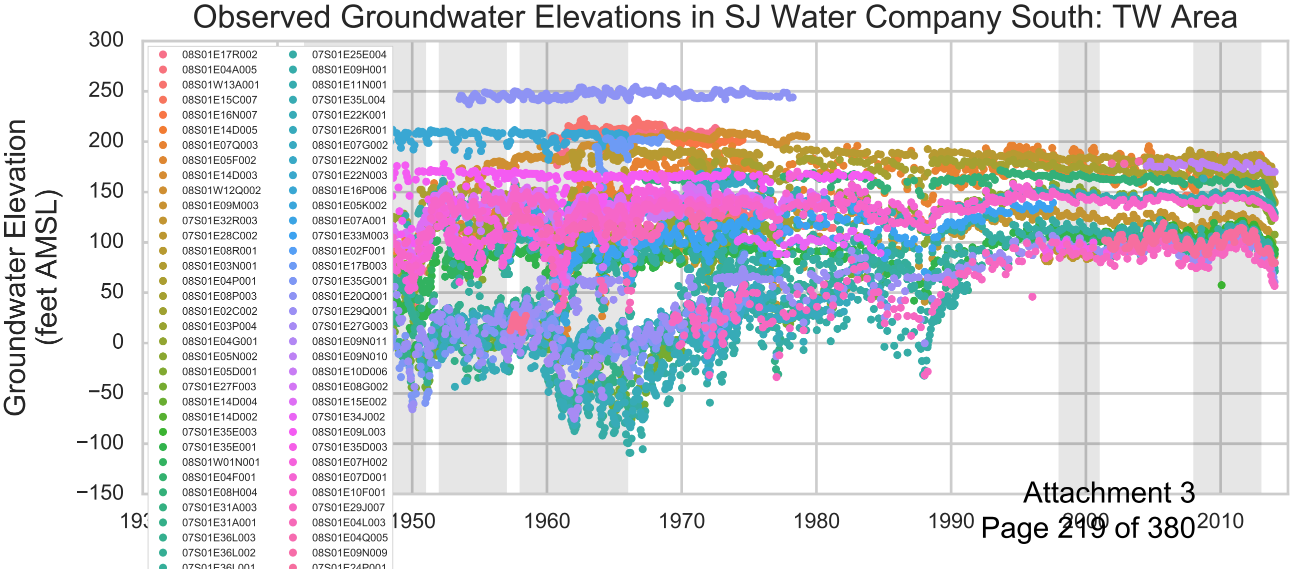
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in SJ Water Company South: TW Area



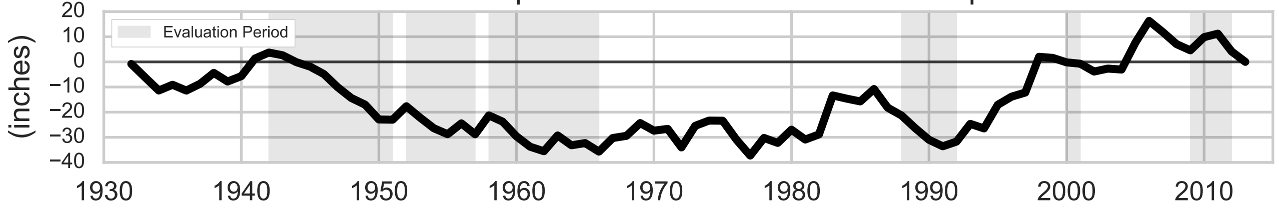
District Activity: Santa Clara Subbasin Managed Recharge



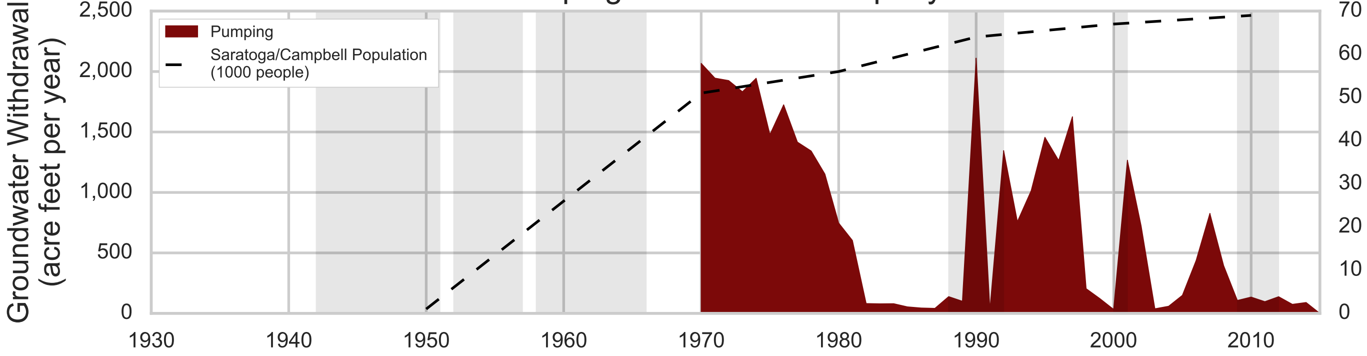
Observed Groundwater Elevations in SJ Water Company South: TW Area

Pumping Area: SJ Water Company West: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

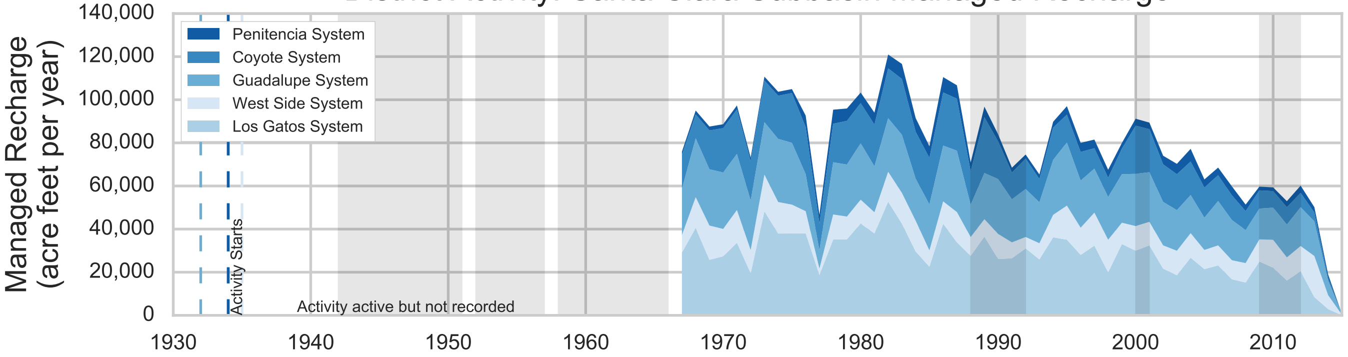
DRAFT



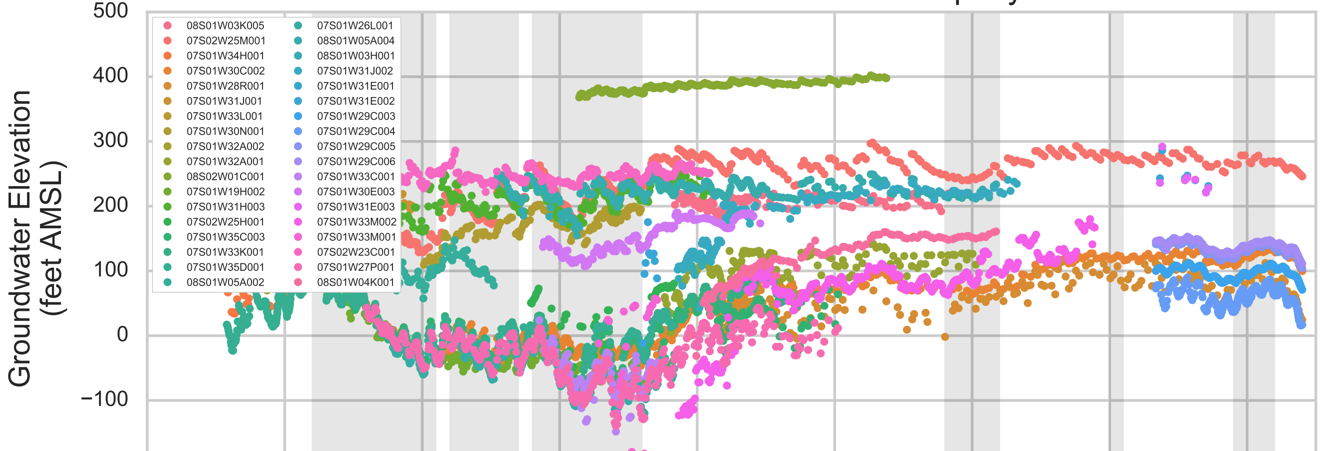
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in SJ Water Company West: TW Area



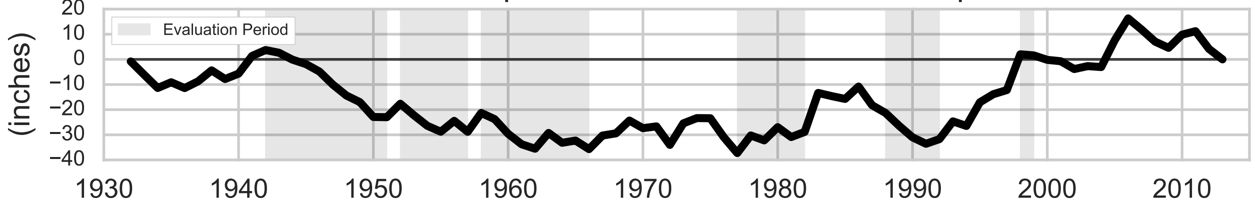
District Activity: Santa Clara Subbasin Managed Recharge



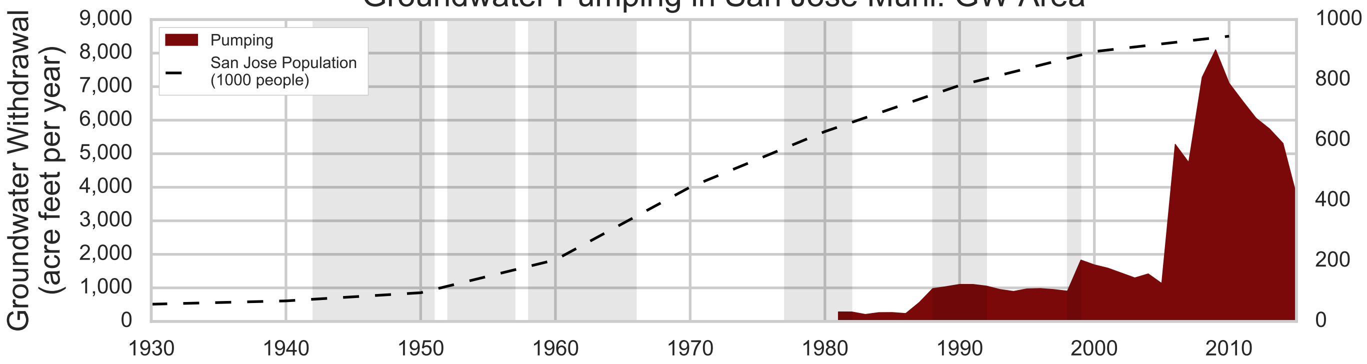
Observed Groundwater Elevations in SJ Water Company West: TW Area

Pumping Area: San Jose Muni: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

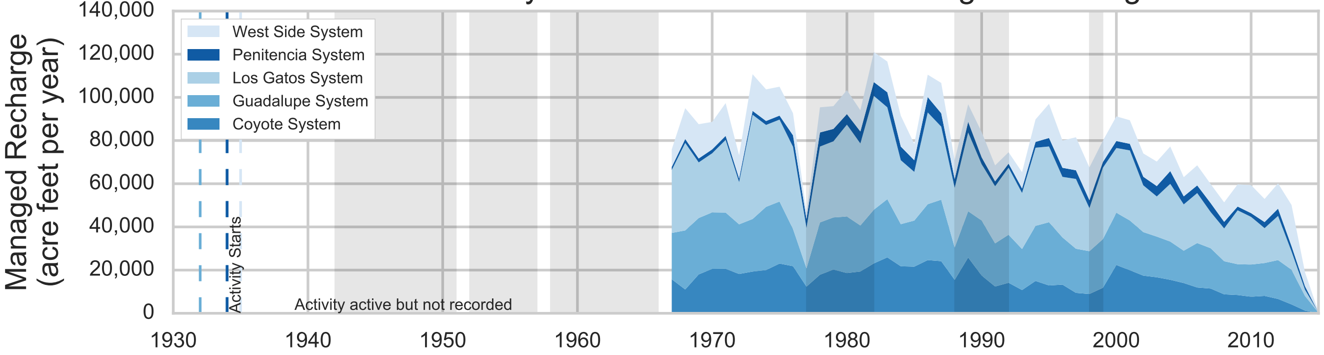
Cumulative Departure from Mean Annual Precipitation



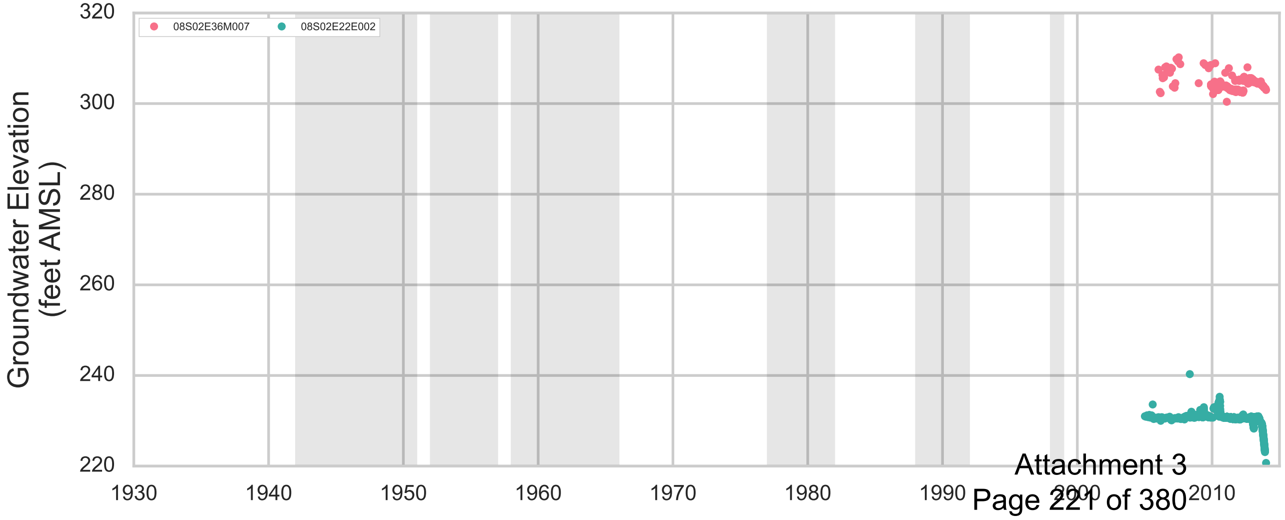
Groundwater Pumping in San Jose Muni: GW Area



District Activity: Santa Clara Subbasin Managed Recharge

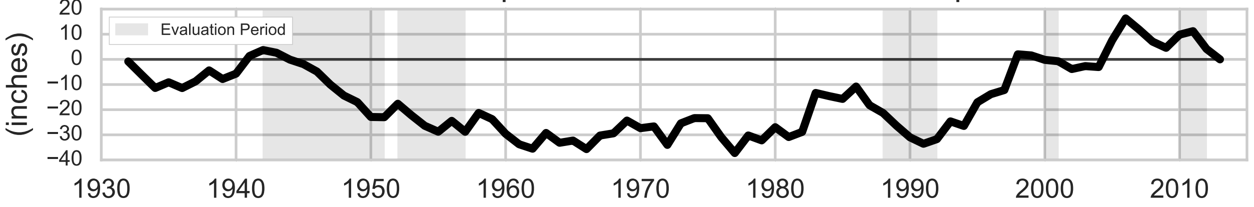


Observed Groundwater Elevations in San Jose Muni: GW Area

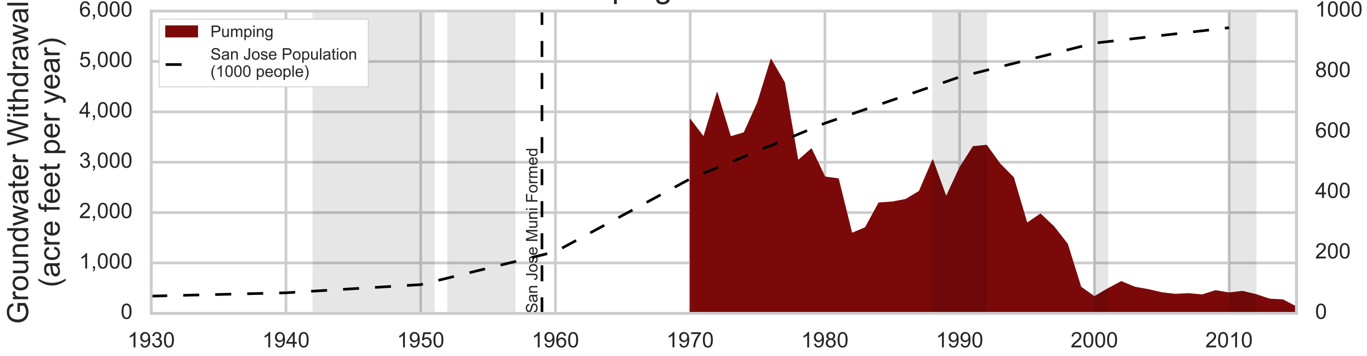


Pumping Area: San Jose Muni: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

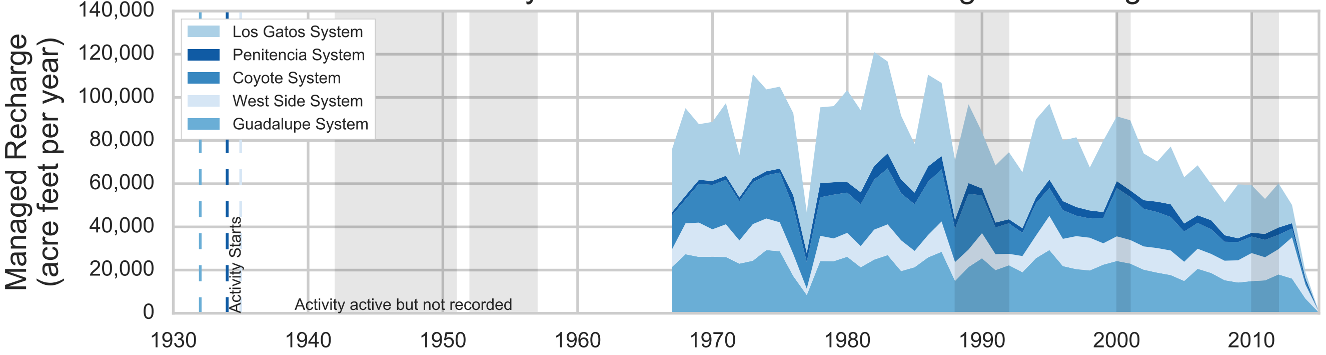
Cumulative Departure from Mean Annual Precipitation



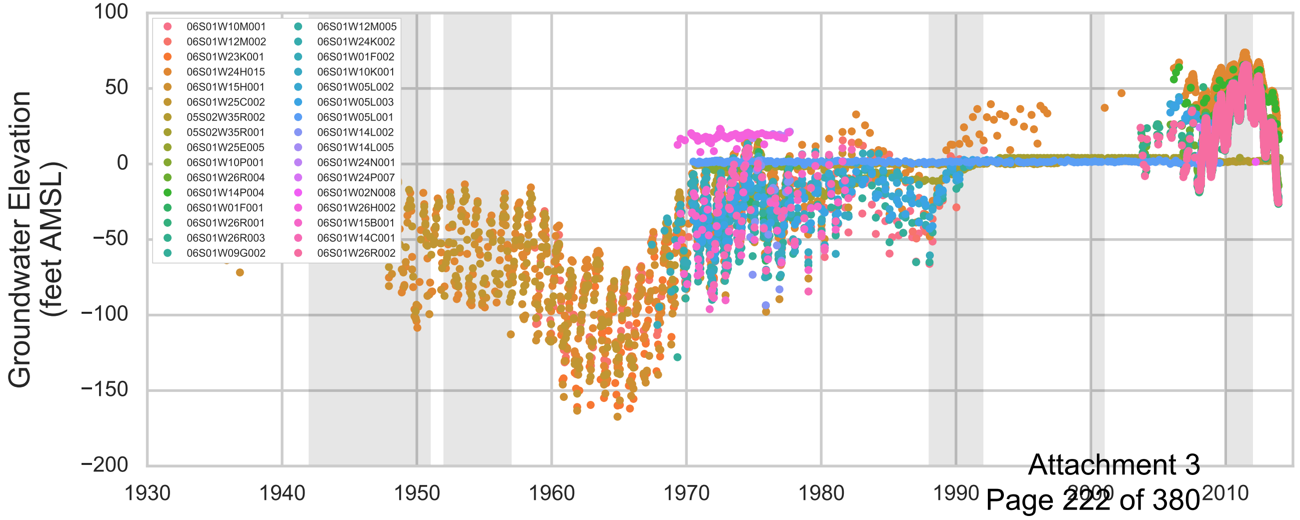
Groundwater Pumping in San Jose Muni: RWS Area



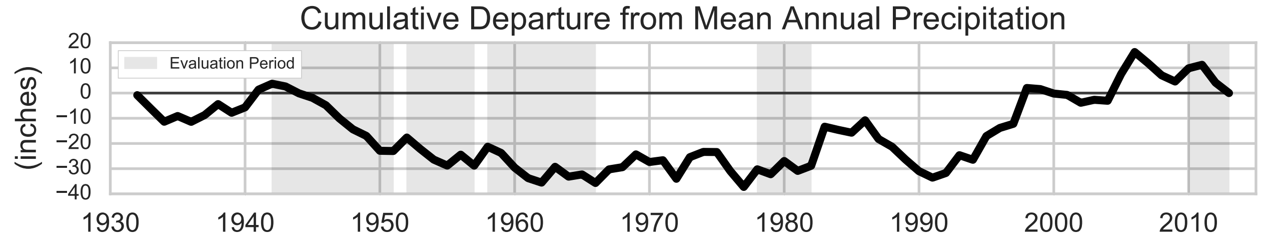
District Activity: Santa Clara Subbasin Managed Recharge



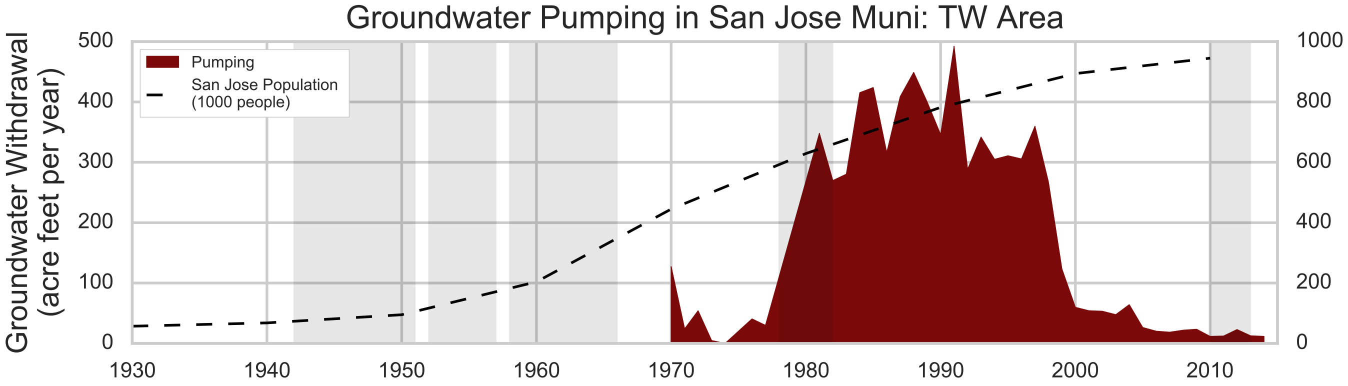
Observed Groundwater Elevations in San Jose Muni: RWS Area



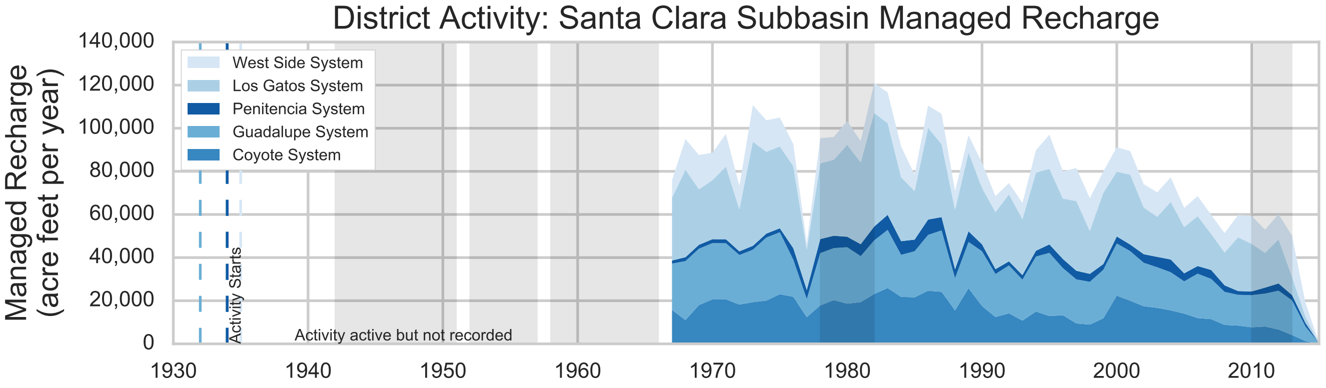
Pumping Area: San Jose Muni: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells



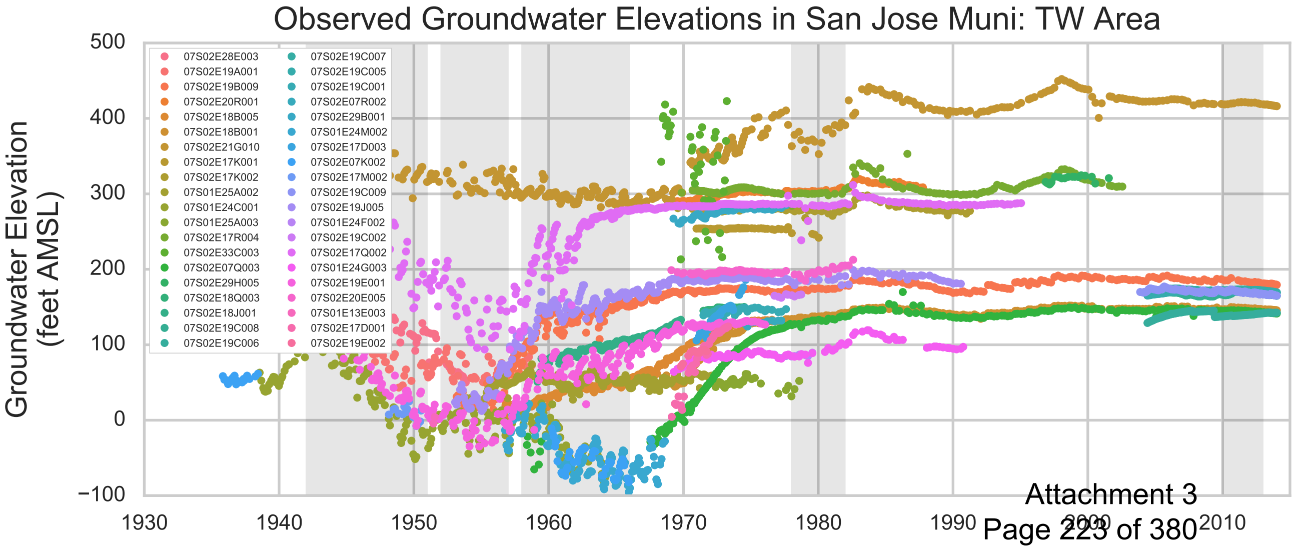
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in San Jose Muni: TW Area



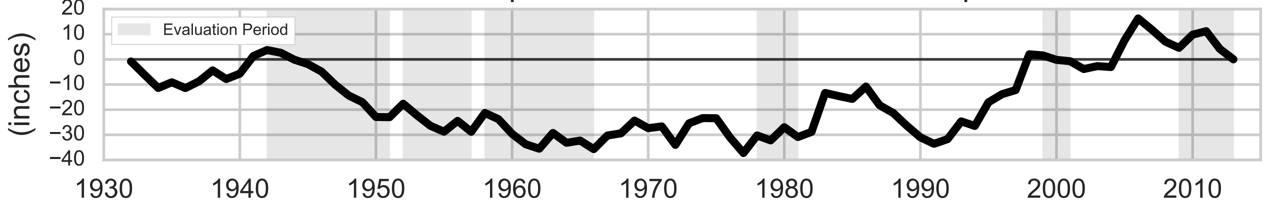
District Activity: Santa Clara Subbasin Managed Recharge



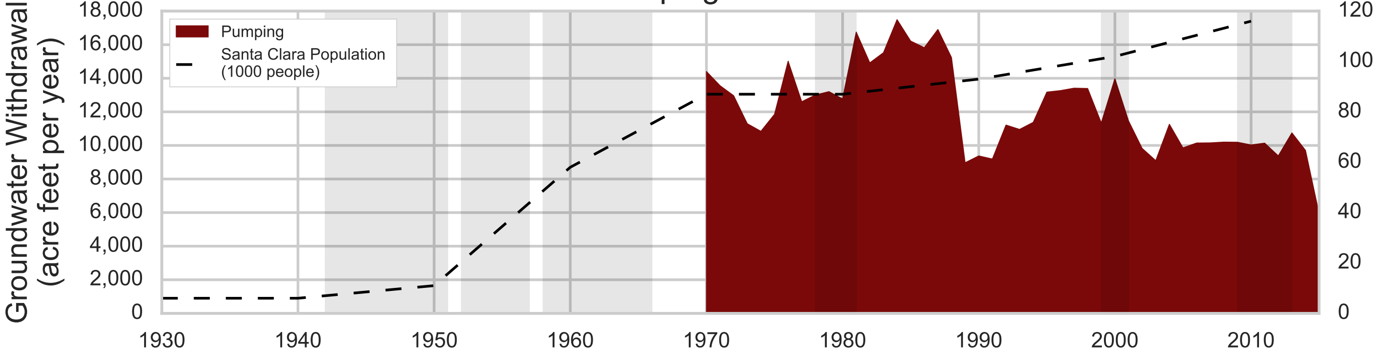
Observed Groundwater Elevations in San Jose Muni: TW Area

Pumping Area: Santa Clara: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

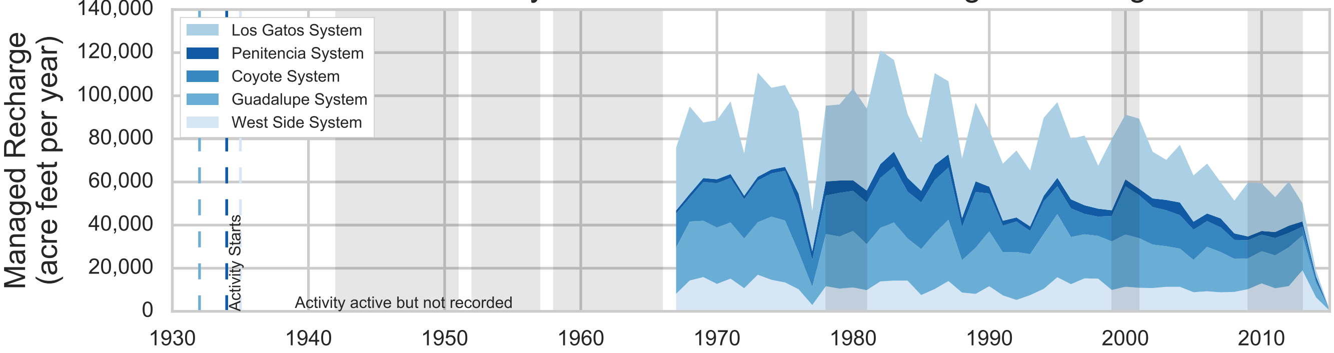
Cumulative Departure from Mean Annual Precipitation



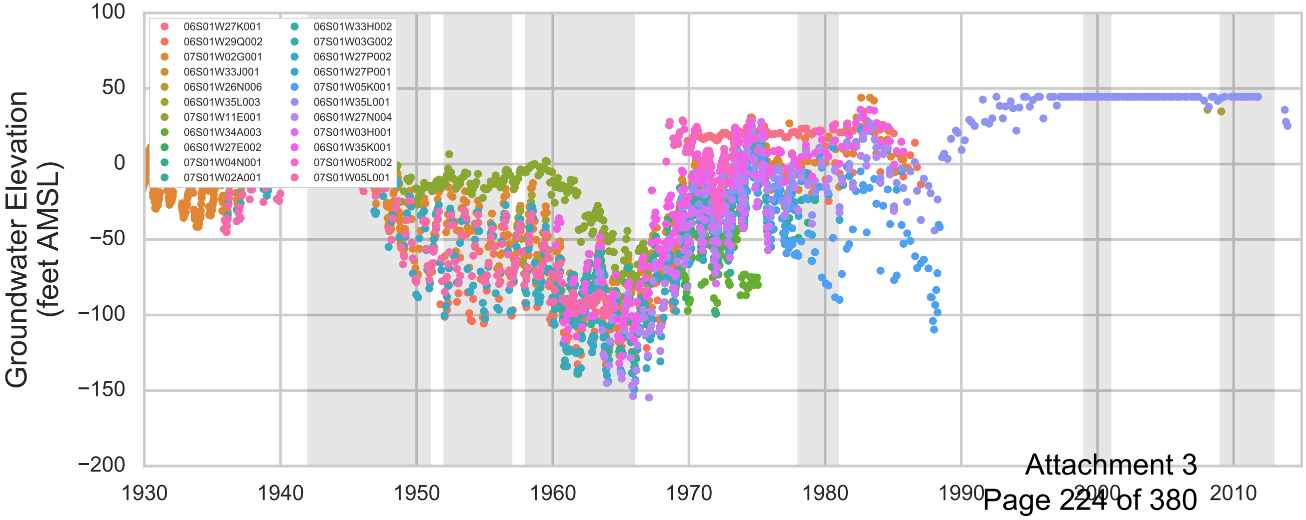
Groundwater Pumping in Santa Clara: GW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in Santa Clara: GW Area



Pumping Area: Santa Clara: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

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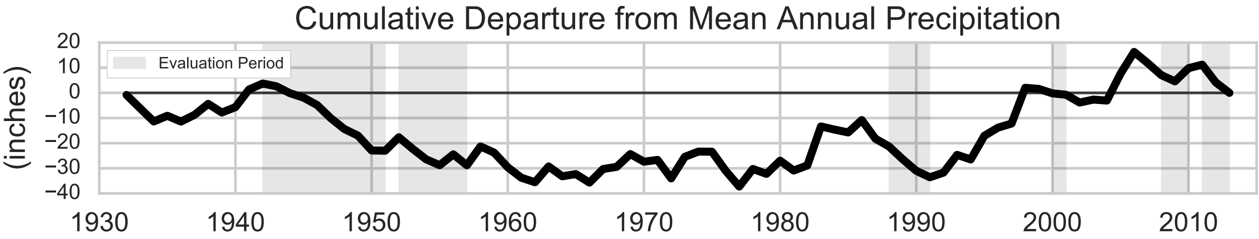
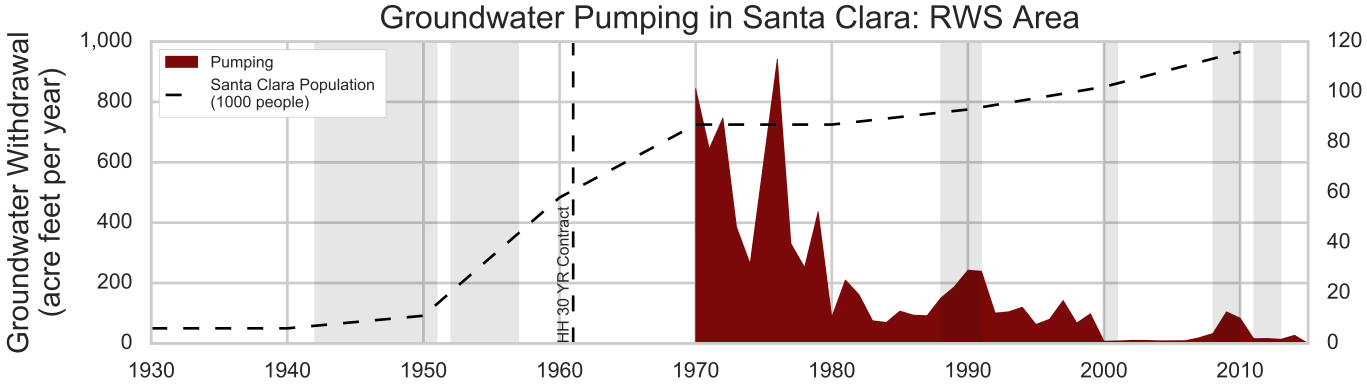
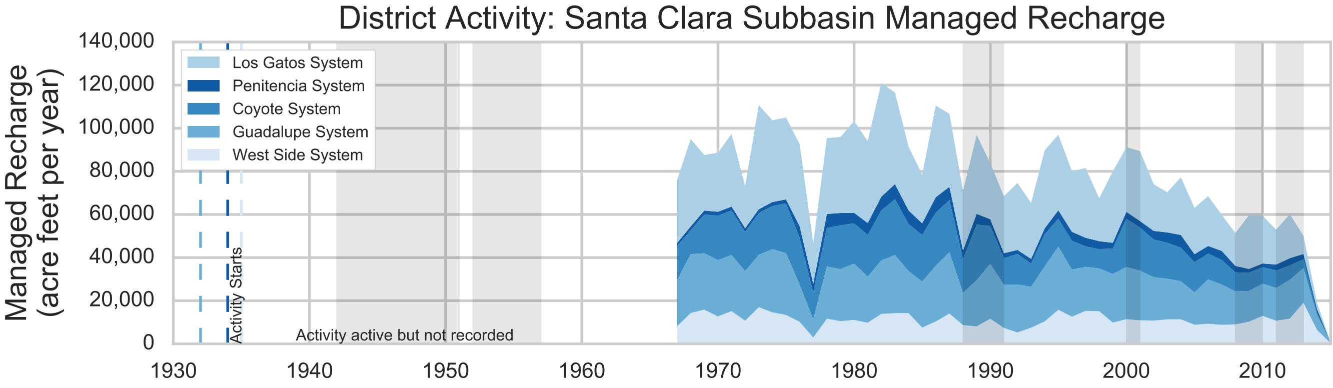


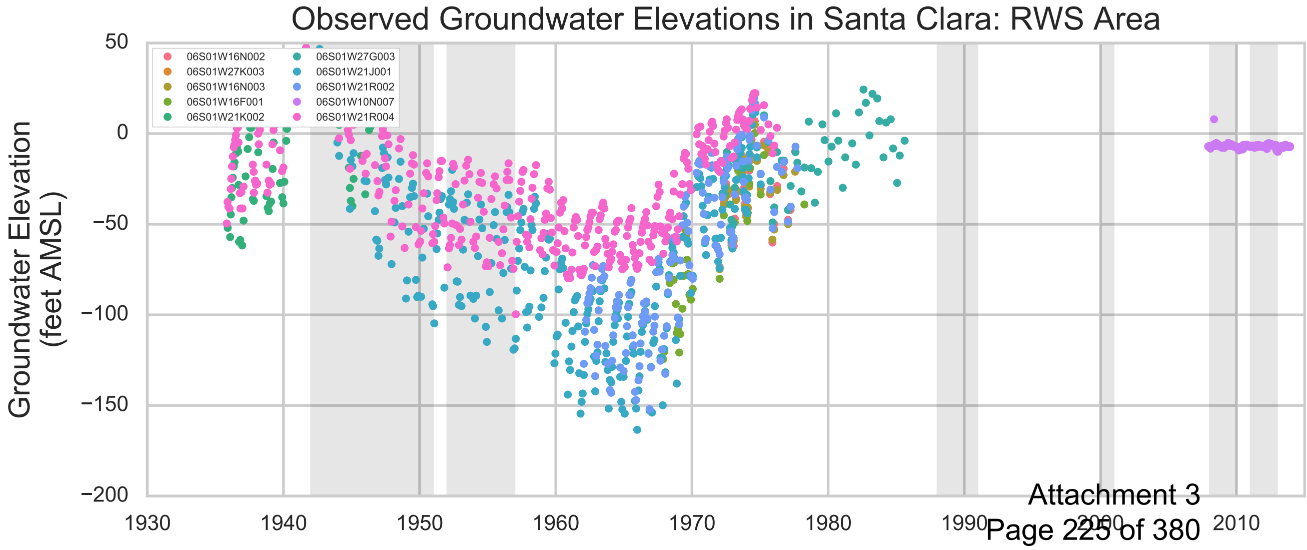
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in Santa Clara: RWS Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in Santa Clara: RWS Area

Pumping Area: Santa Clara: RWS GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

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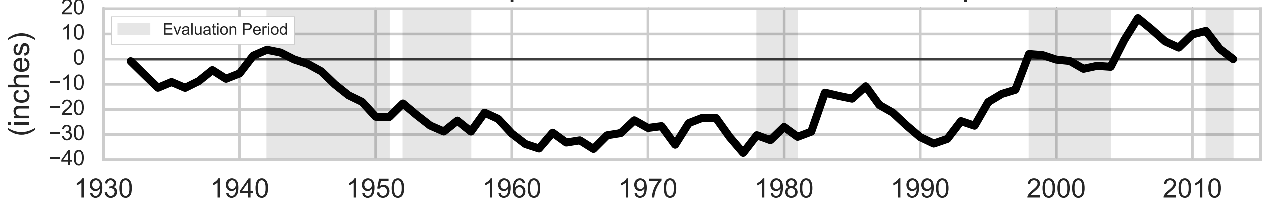
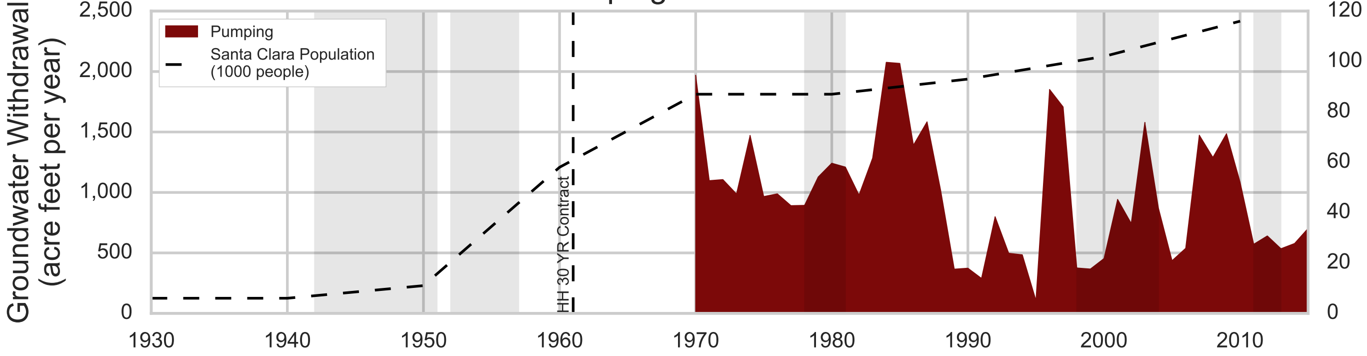
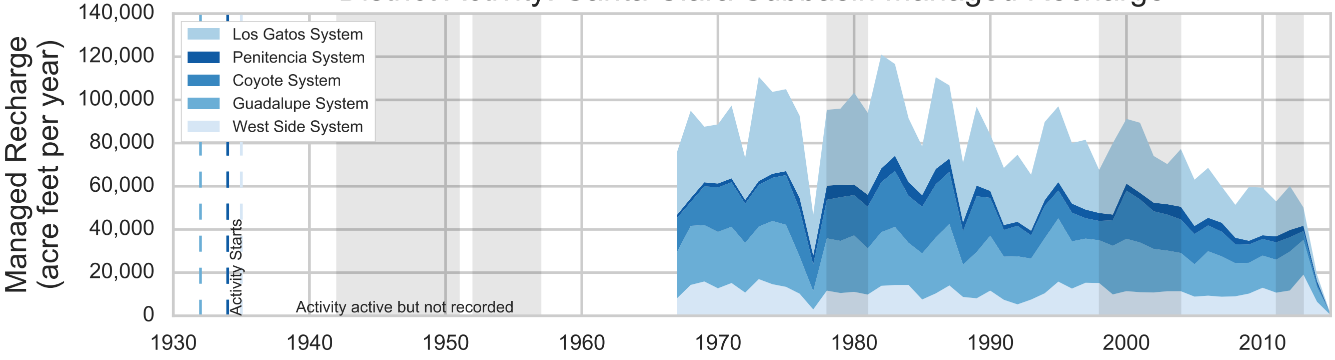
Cumulative Departure from Mean Annual Precipitation



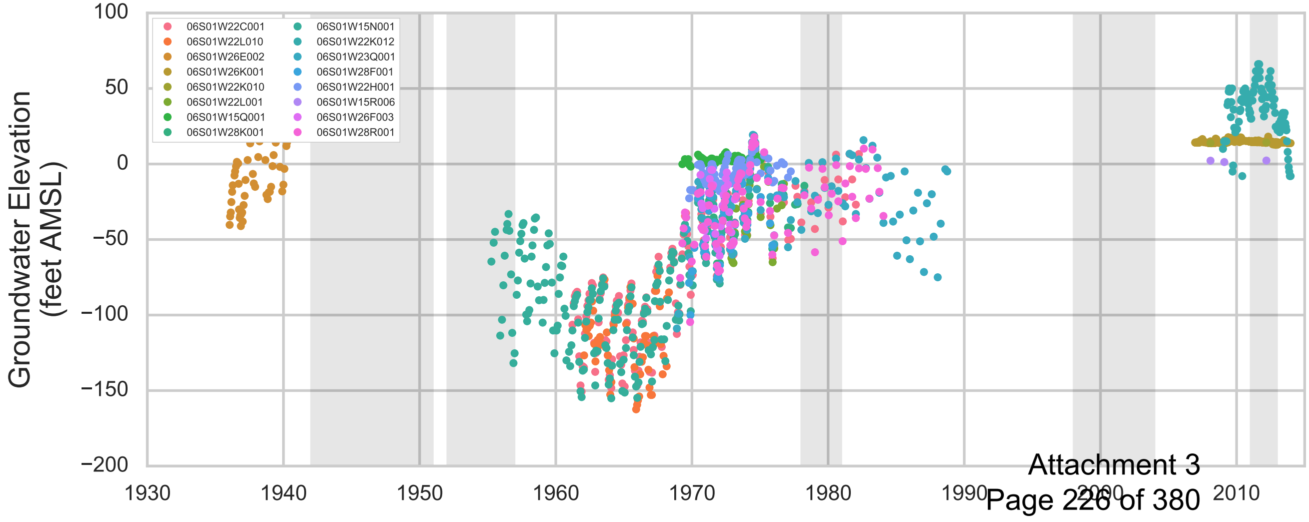
Groundwater Pumping in Santa Clara: RWS GW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in Santa Clara: RWS GW Area



Pumping Area: Santa Clara: TW GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

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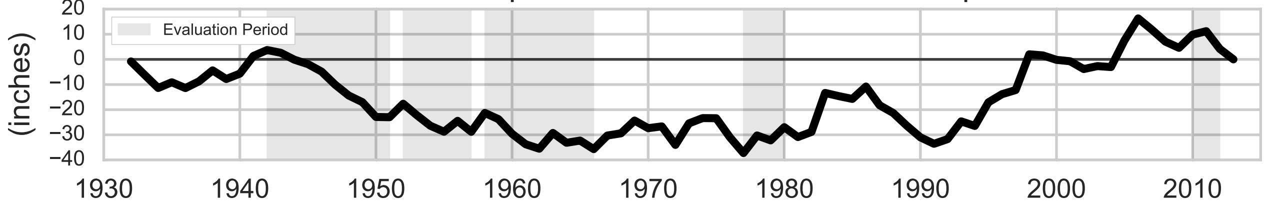
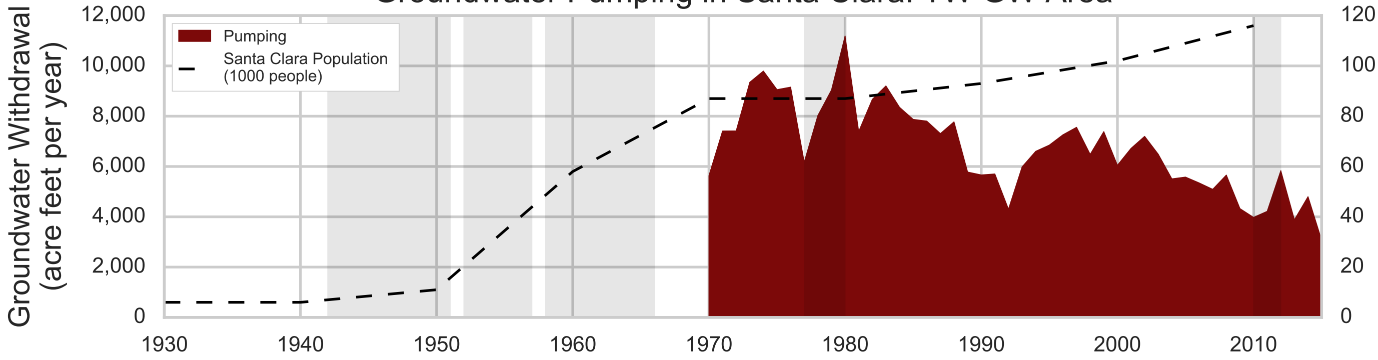
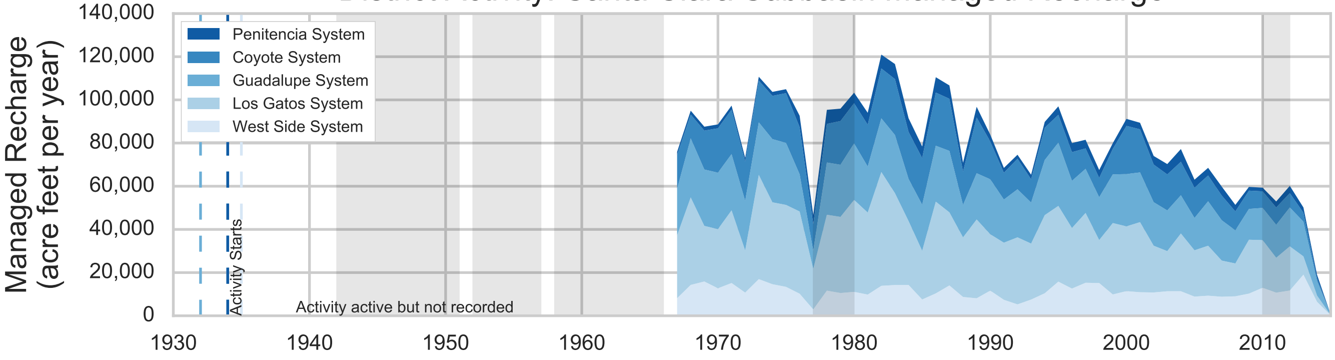
Cumulative Departure from Mean Annual Precipitation



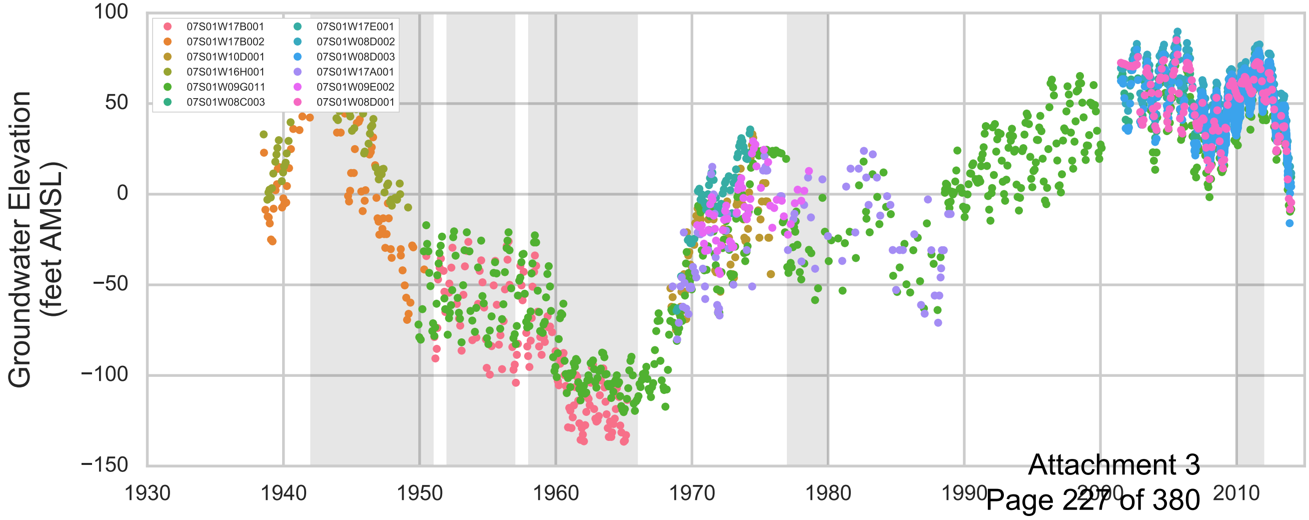
Groundwater Pumping in Santa Clara: TW GW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in Santa Clara: TW GW Area



Pumping Area: Sunnyvale: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

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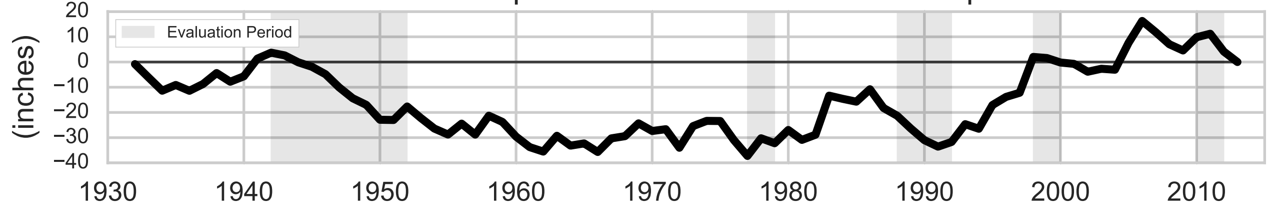
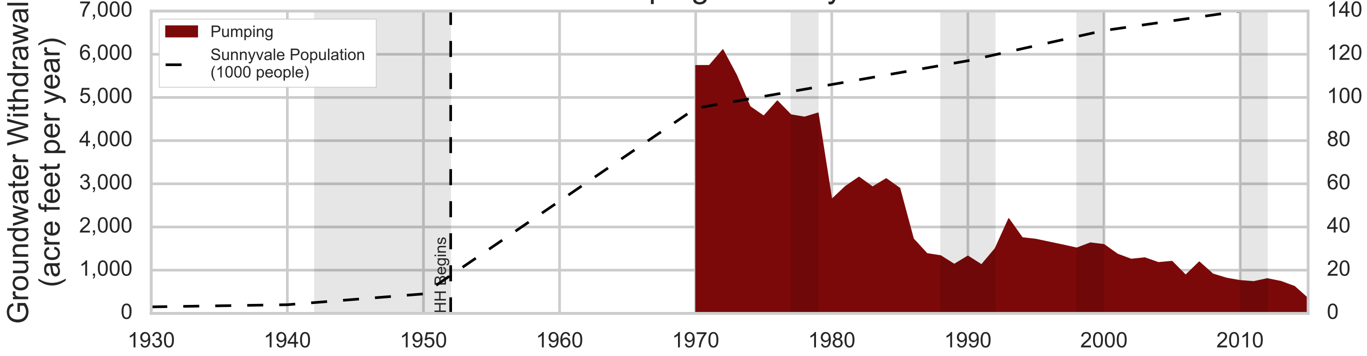
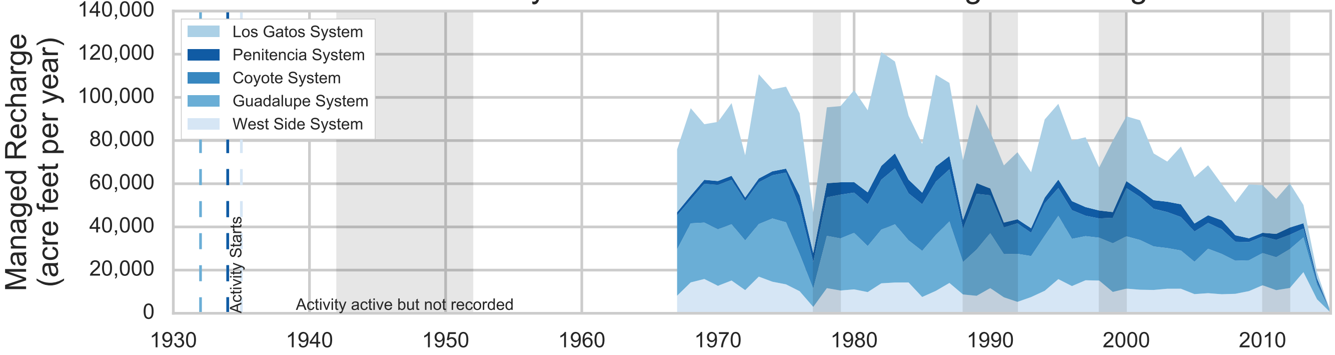
Cumulative Departure from Mean Annual Precipitation



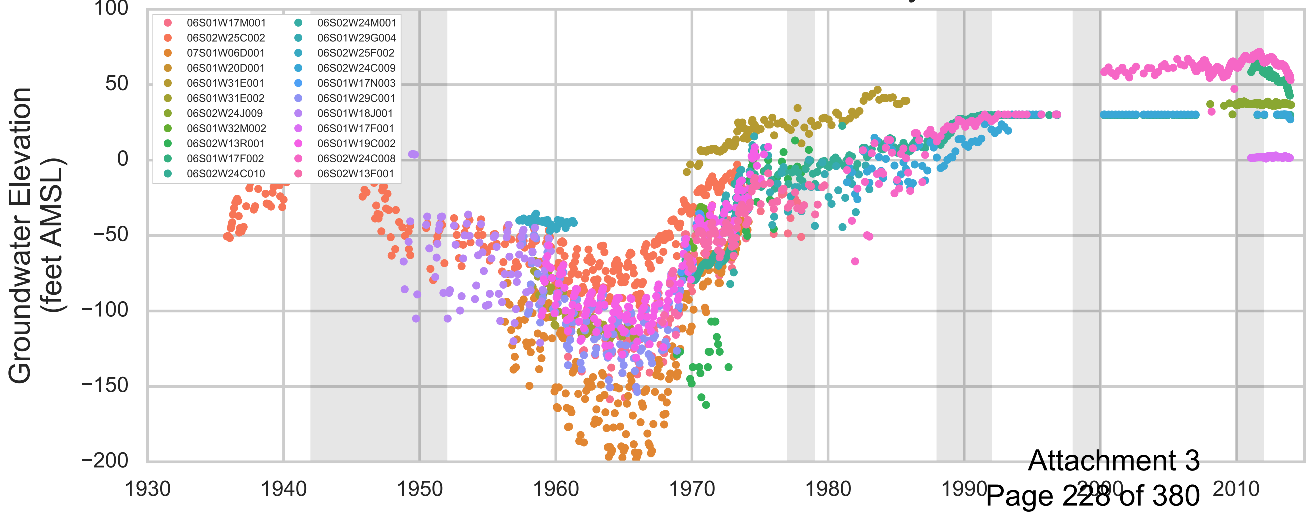
Groundwater Pumping in Sunnyvale: RWS Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in Sunnyvale: RWS Area



Pumping Area: Sunnyvale: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

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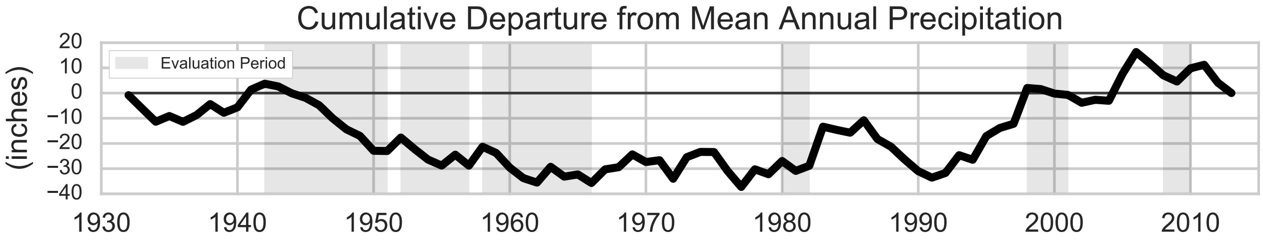
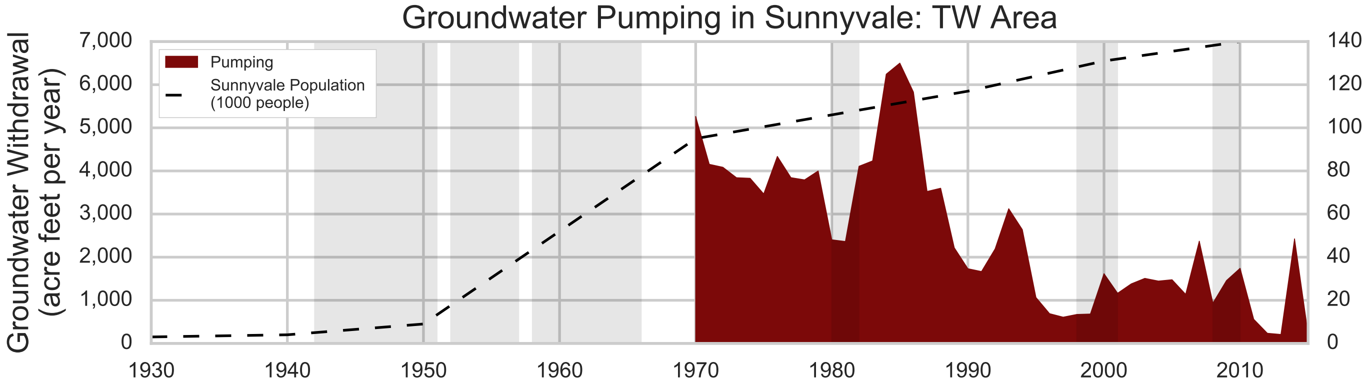
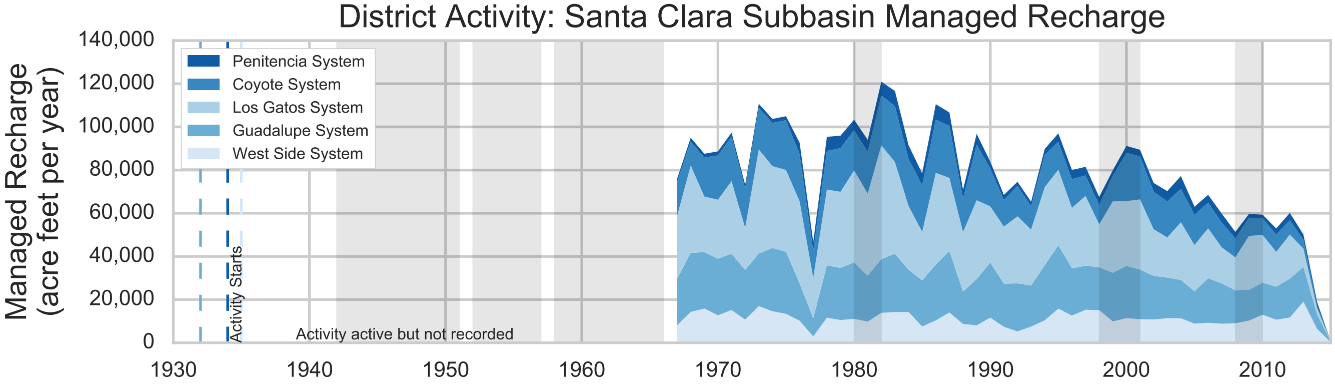
Cumulative Departure from Mean Annual Precipitation



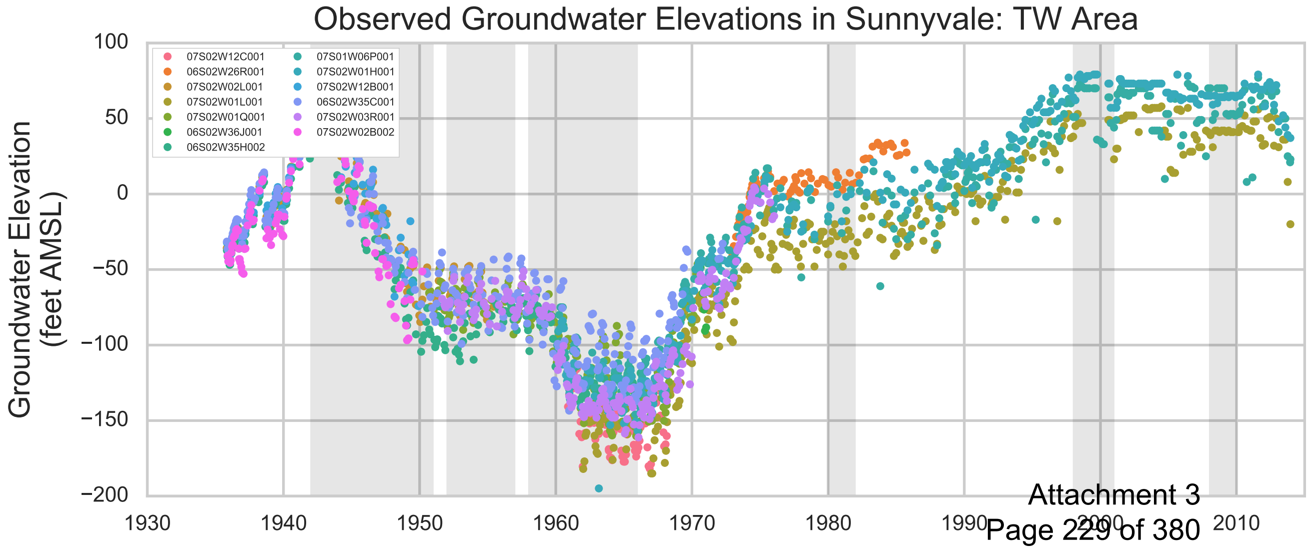
Groundwater Pumping in Sunnyvale: TW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in Sunnyvale: TW Area



Appendix D

Groundwater Level Trends in Monitoring Wells to Evaluate Benefits from Treated Water Deliveries

Pumping Area: Cal Water Los Altos: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

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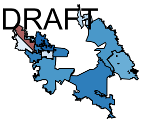
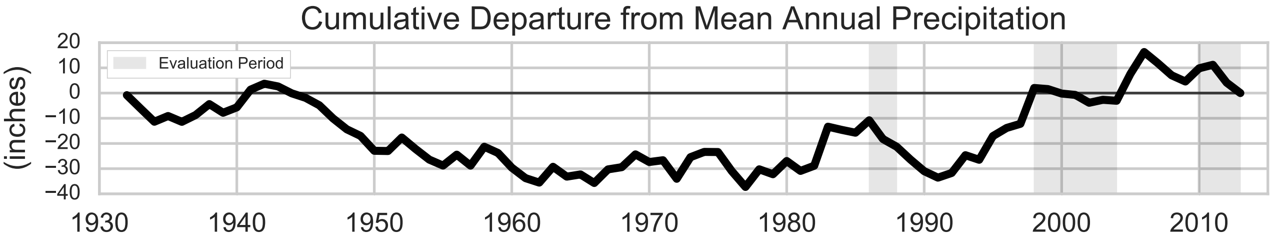
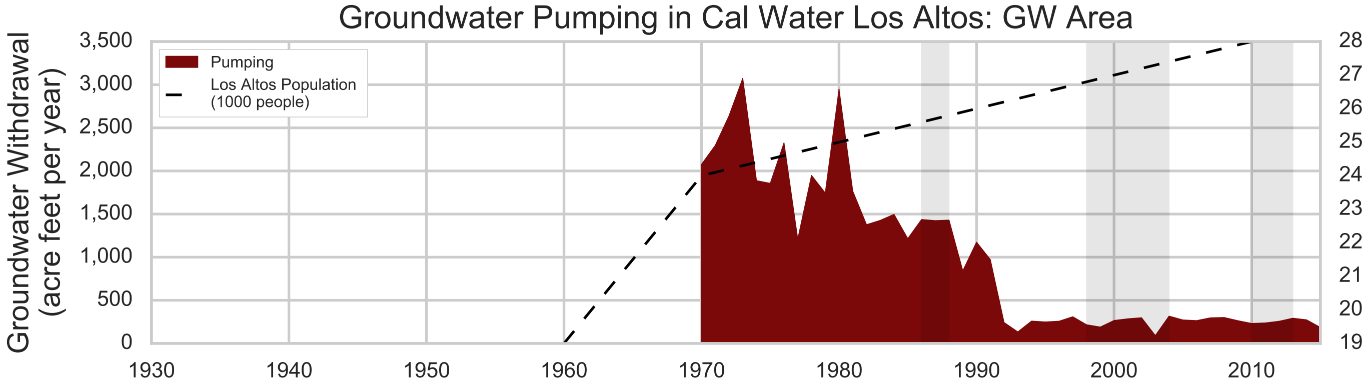
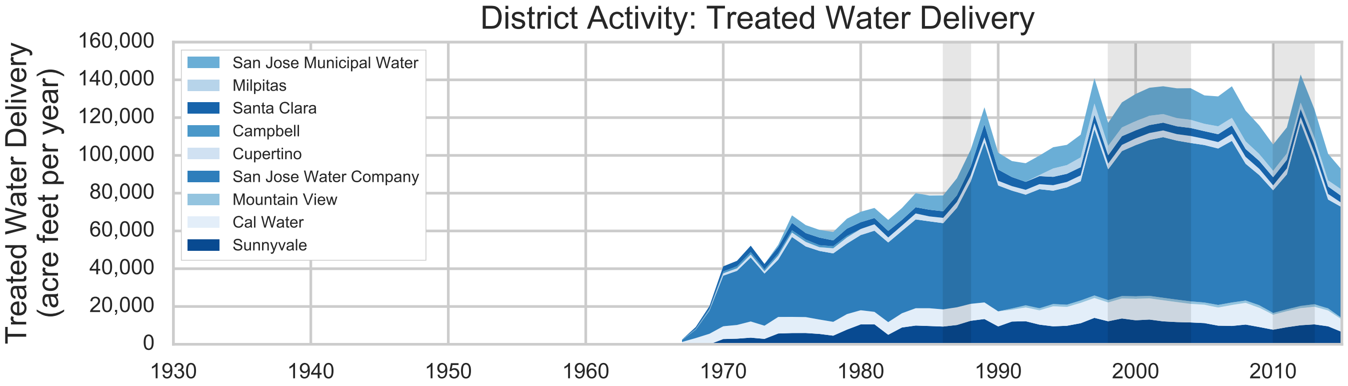
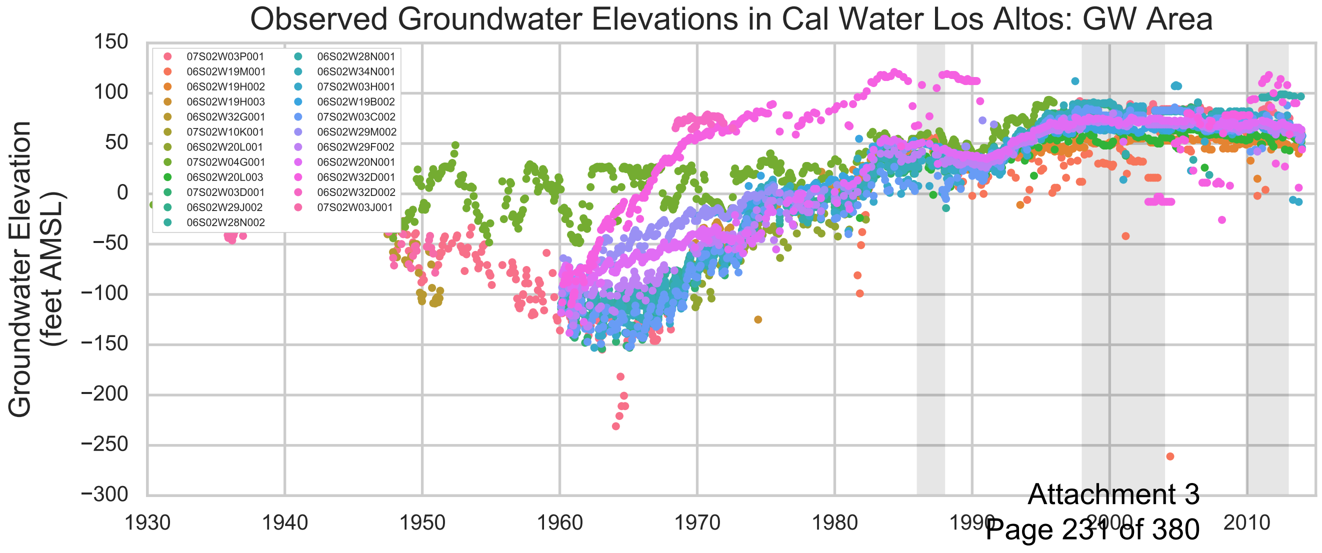



Cumulative Departure from Mean Annual Precipitation

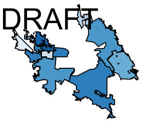

Groundwater Pumping in Cal Water Los Altos: GW Area


District Activity: Treated Water Delivery

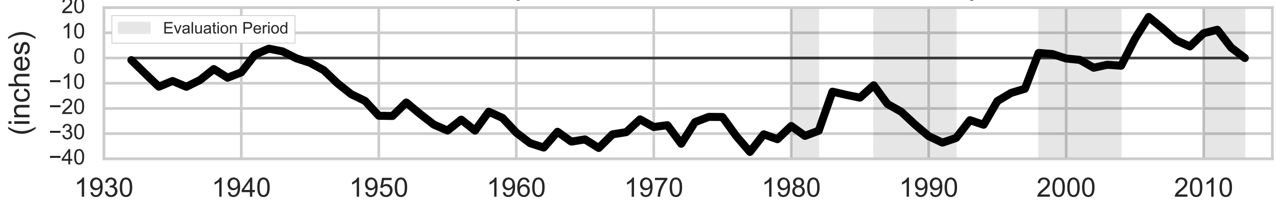

Observed Groundwater Elevations in Cal Water Los Altos: GW Area

Pumping Area: Cal Water Mountain View: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

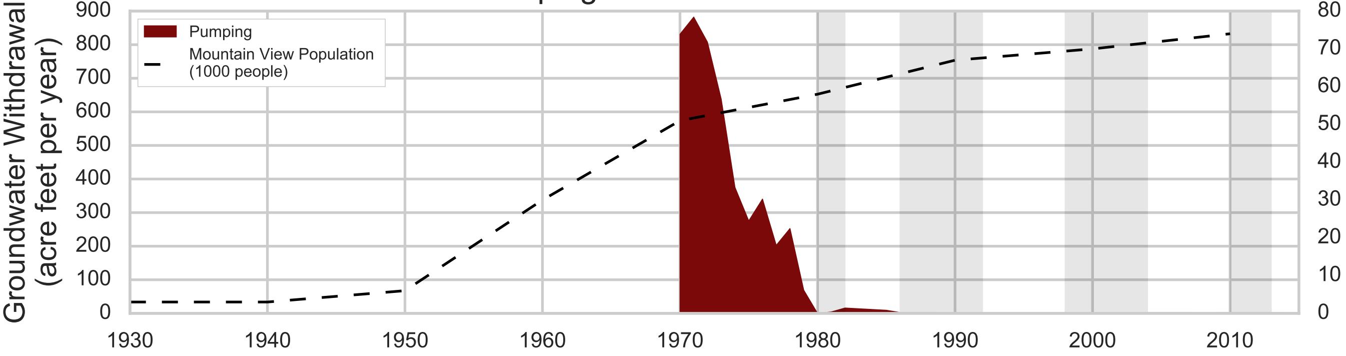
DRAFT



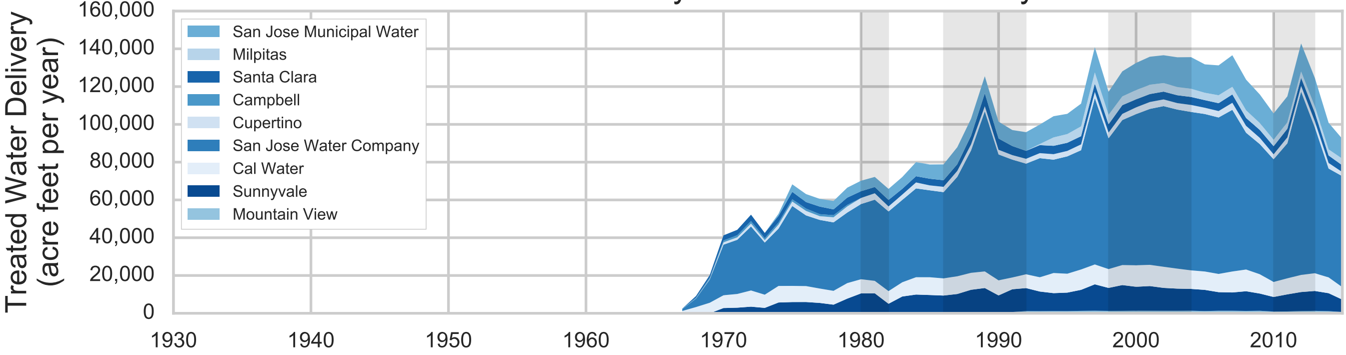
Cumulative Departure from Mean Annual Precipitation



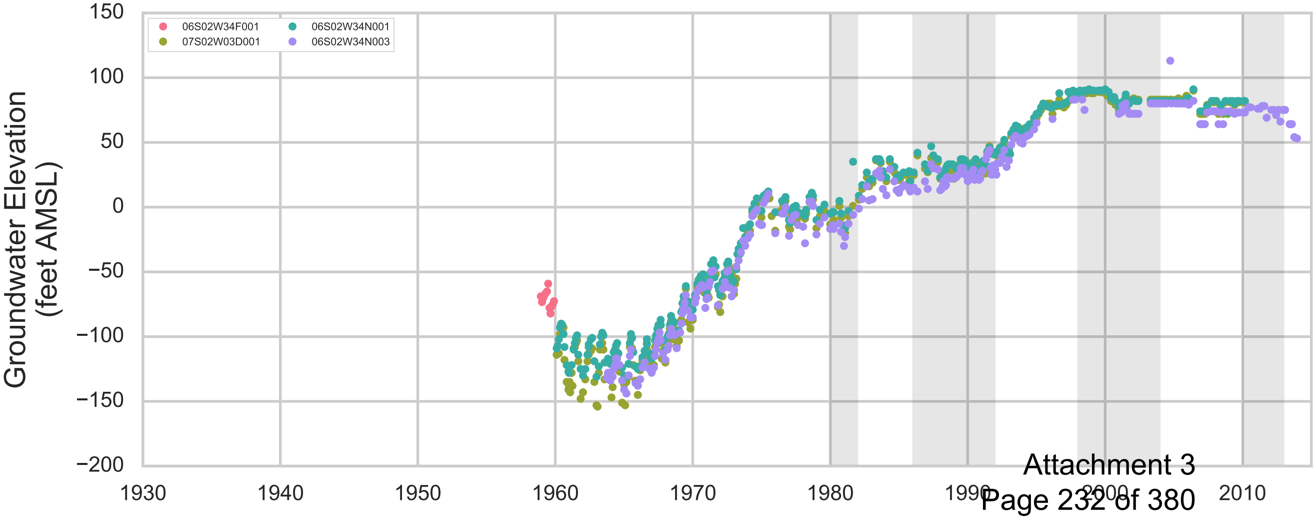
Groundwater Pumping in Cal Water Mountain View: GW Area



District Activity: Treated Water Delivery

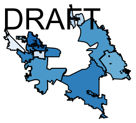


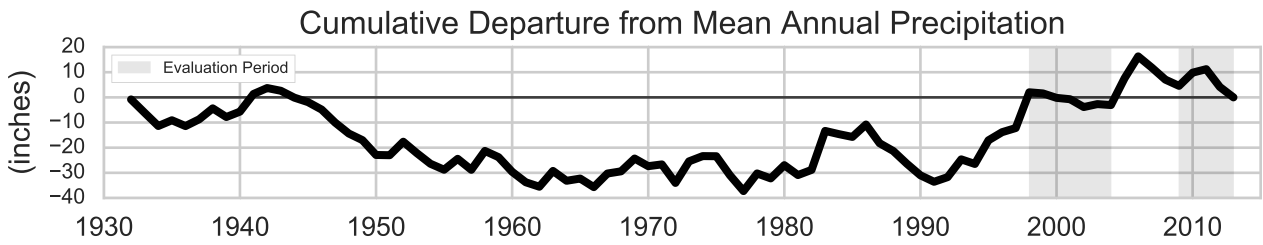
Observed Groundwater Elevations in Cal Water Mountain View: GW Area

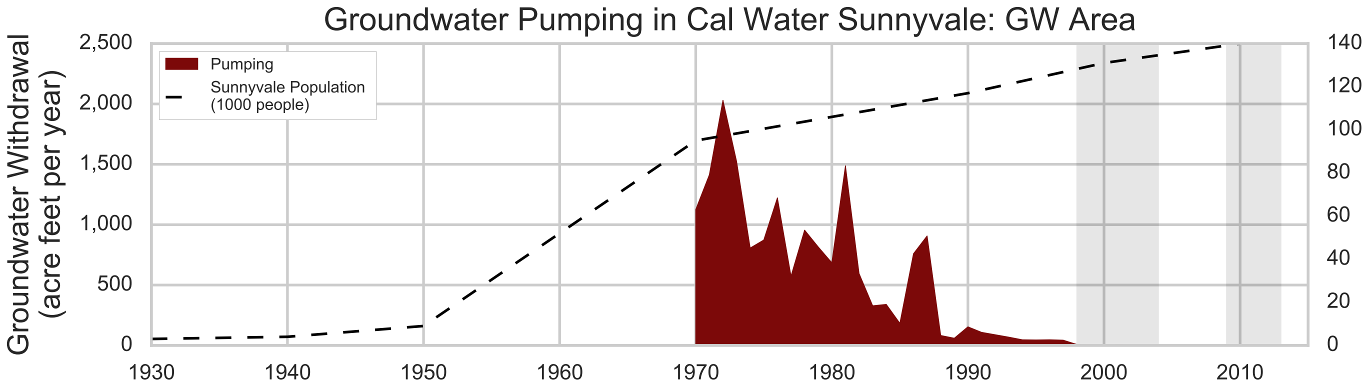


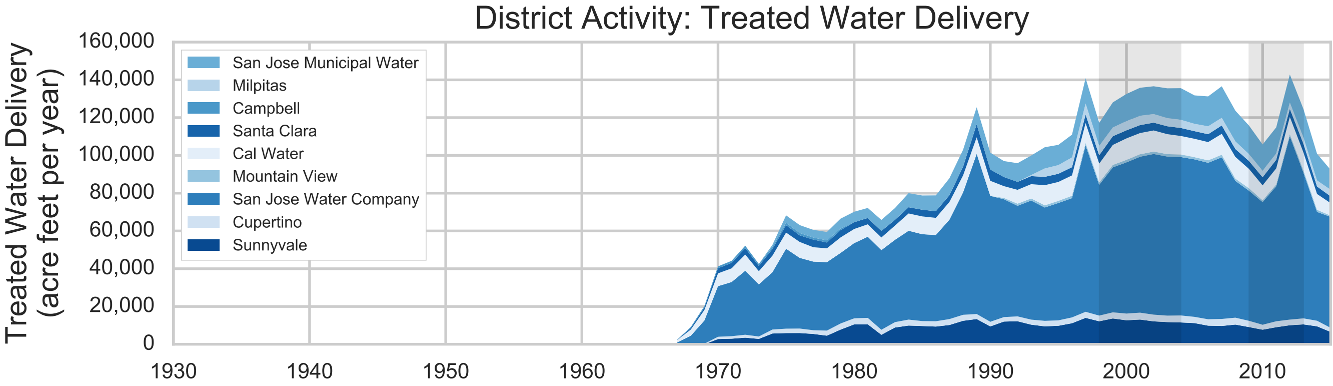
Pumping Area: Cal Water Sunnyvale: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

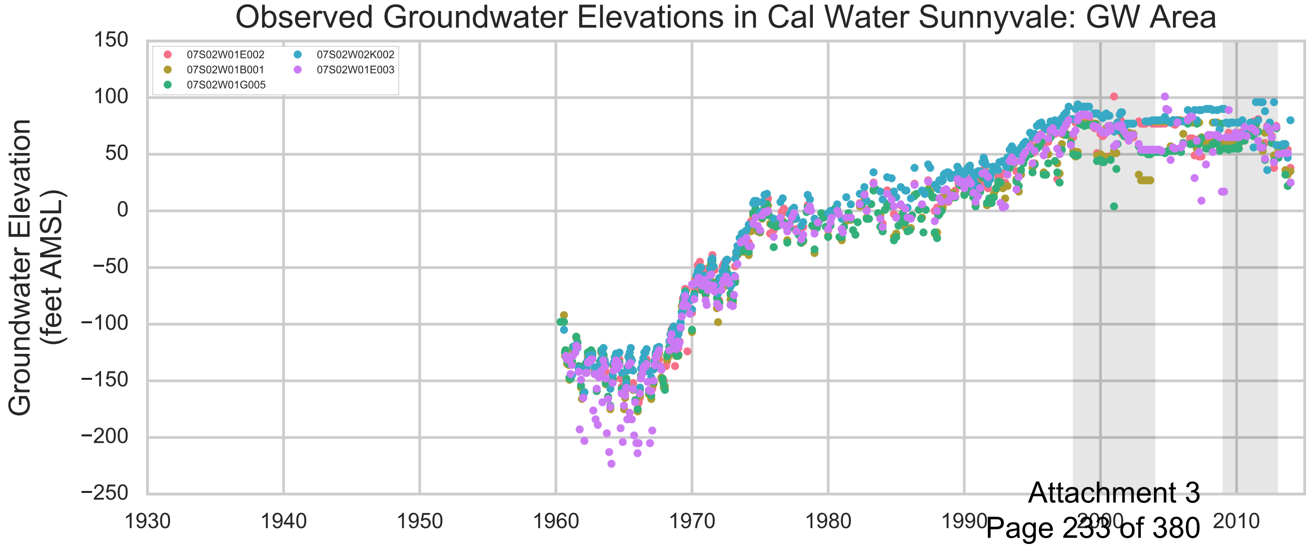
DRAFT



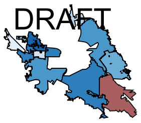




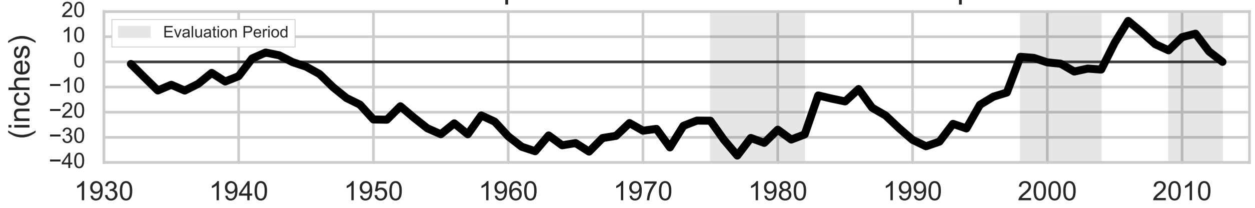




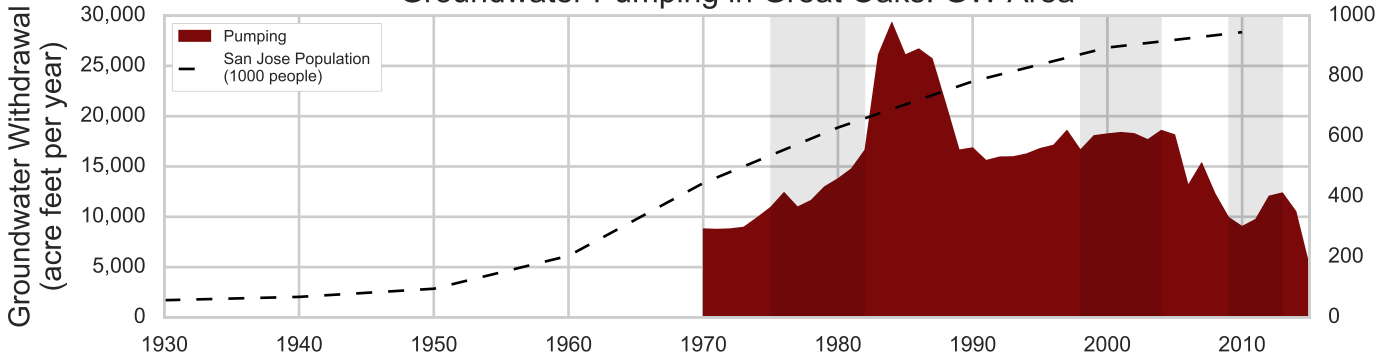
Pumping Area: Great Oaks: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



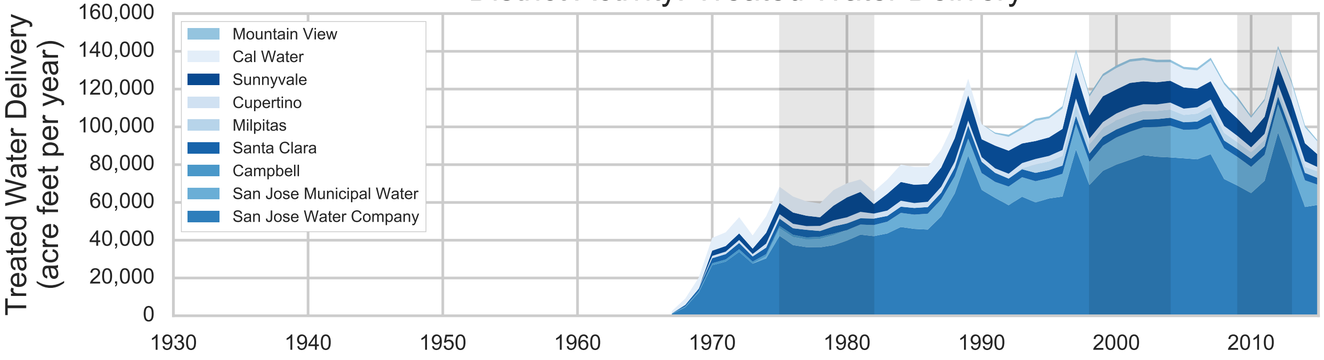
Cumulative Departure from Mean Annual Precipitation



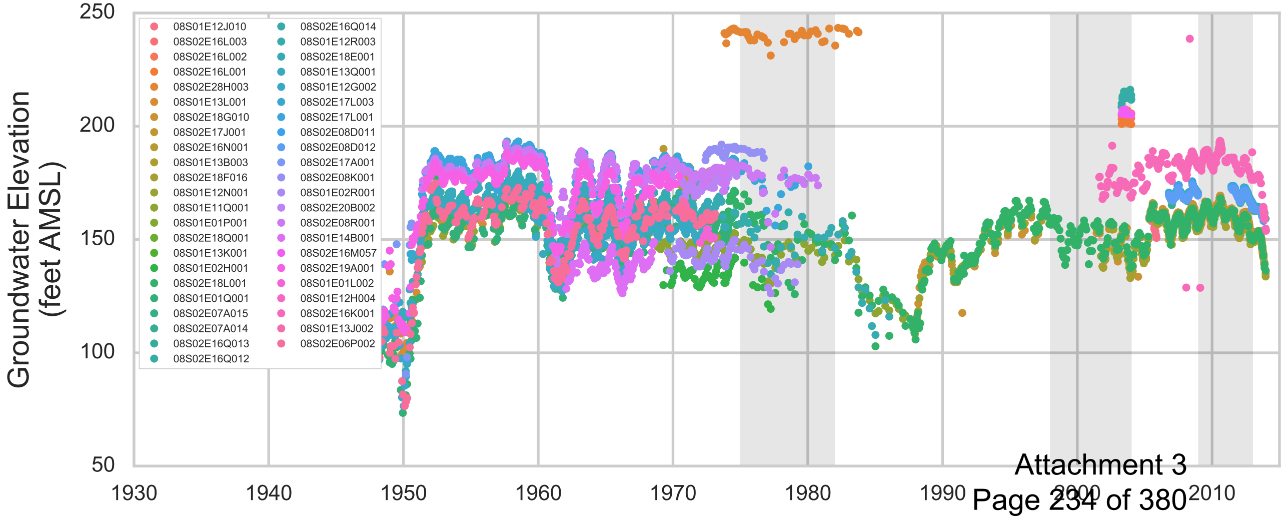
Groundwater Pumping in Great Oaks: GW Area



District Activity: Treated Water Delivery

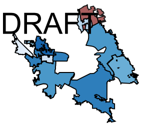


Observed Groundwater Elevations in Great Oaks: GW Area

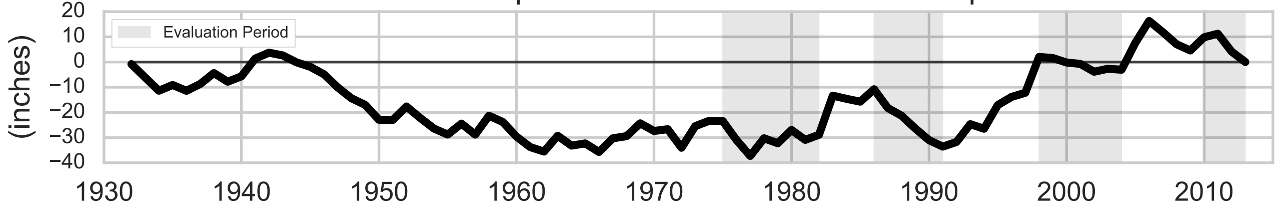


Pumping Area: Milpitas: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

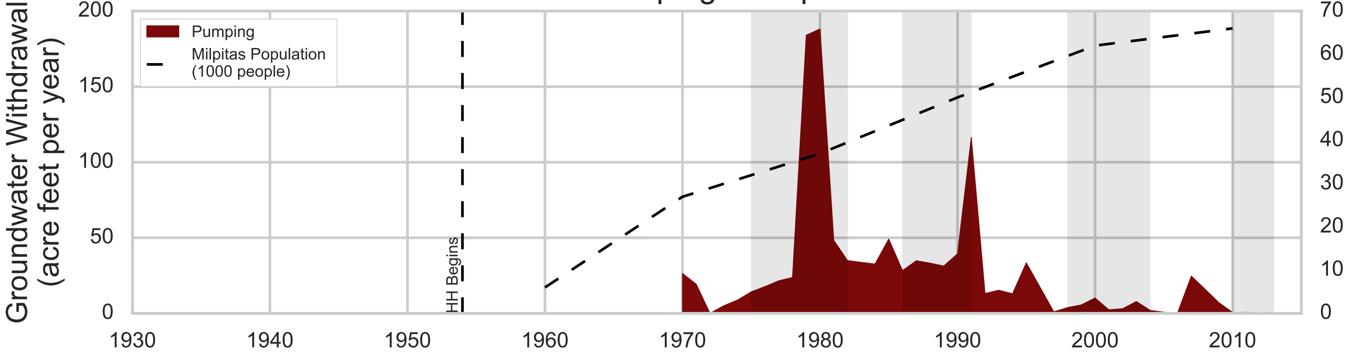
DRAFT



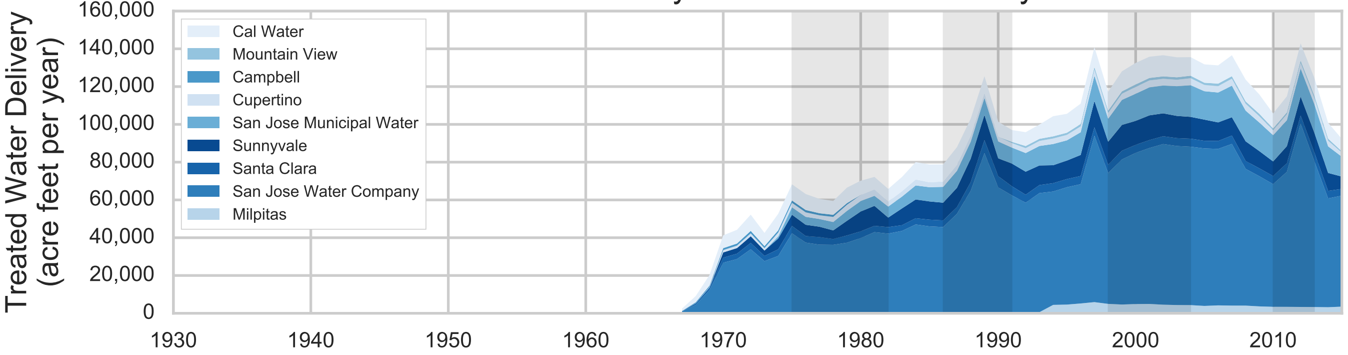
Cumulative Departure from Mean Annual Precipitation



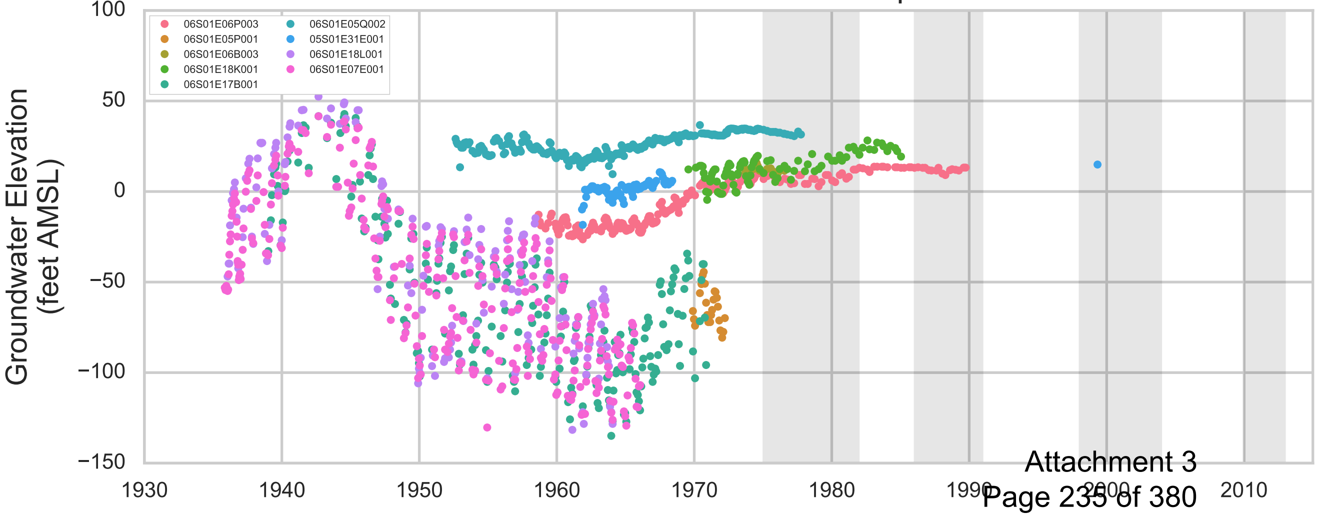
Groundwater Pumping in Milpitas: RWS Area



District Activity: Treated Water Delivery

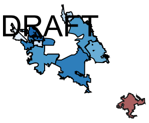


Observed Groundwater Elevations in Milpitas: RWS Area

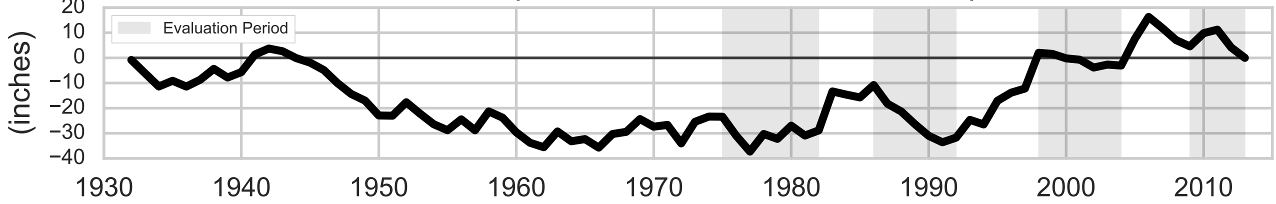


Pumping Area: Morgan Hill: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

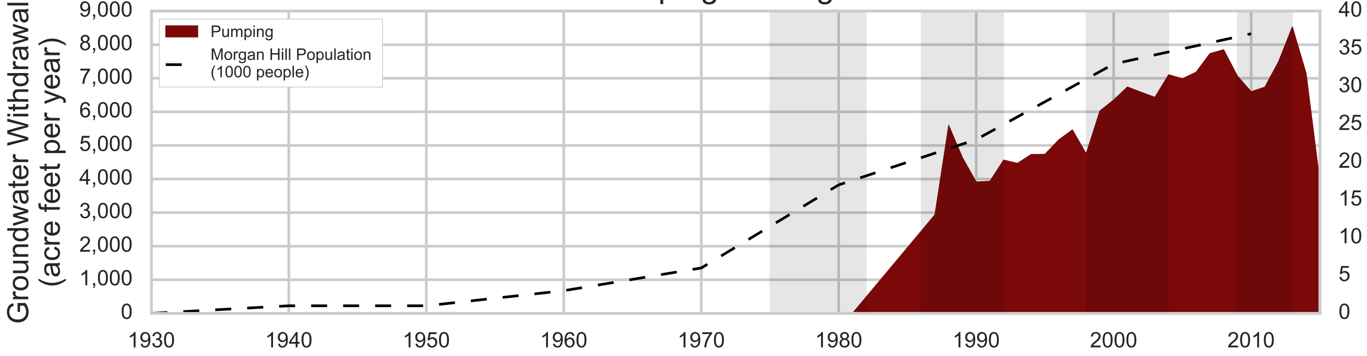
DRAFT



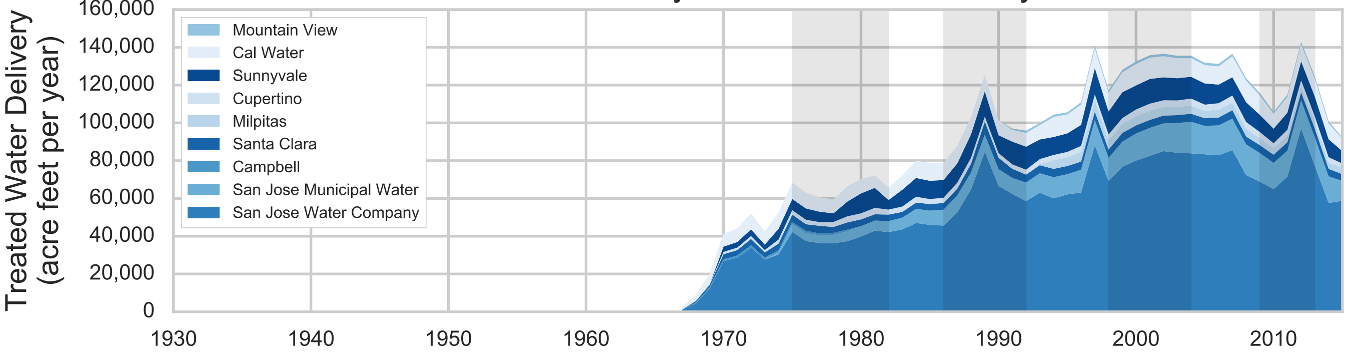
Cumulative Departure from Mean Annual Precipitation



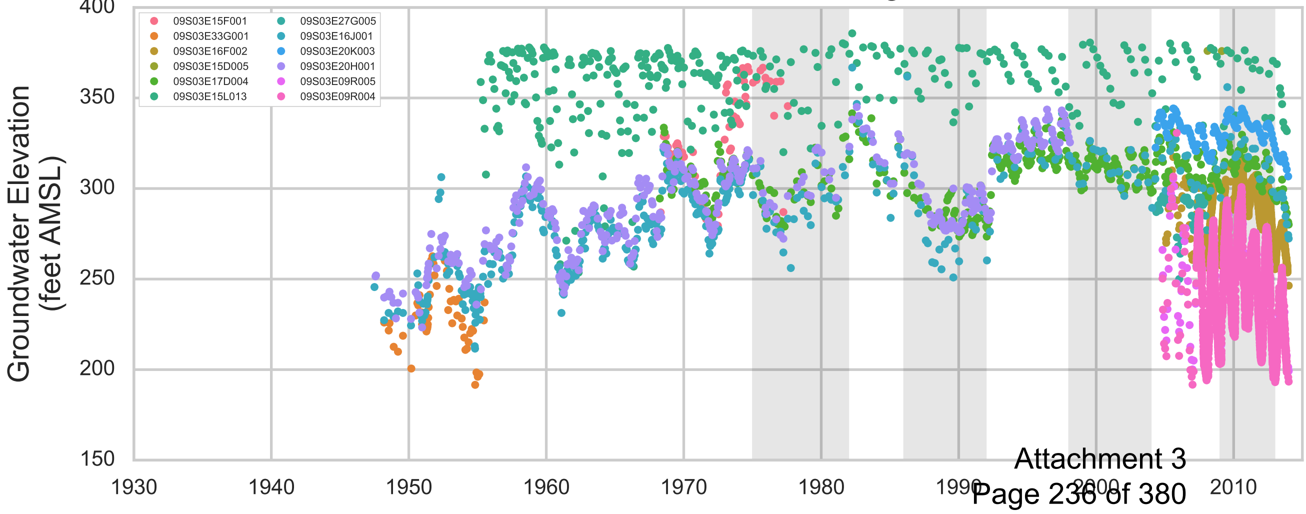
Groundwater Pumping in Morgan Hill: GW Area



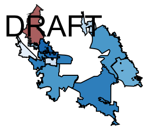
District Activity: Treated Water Delivery



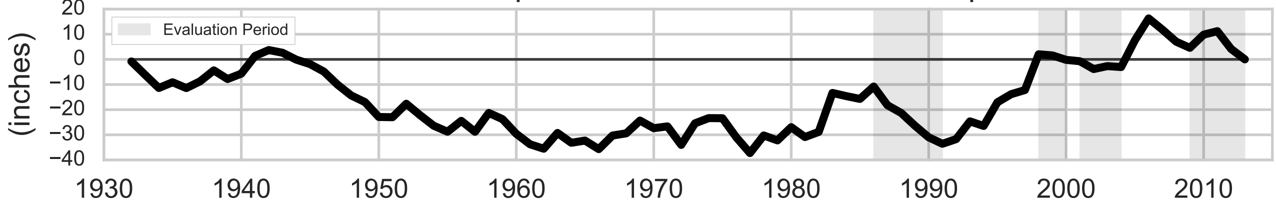
Observed Groundwater Elevations in Morgan Hill: GW Area



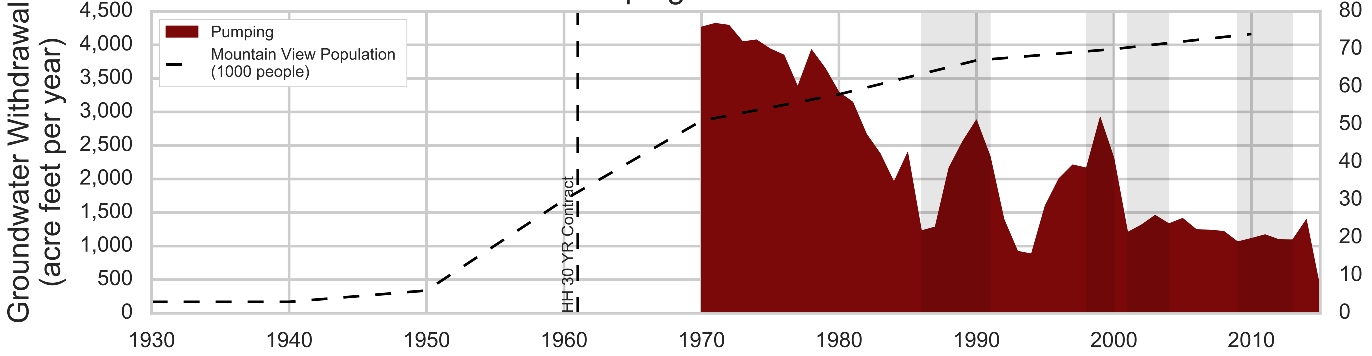
Pumping Area: Mountain View: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



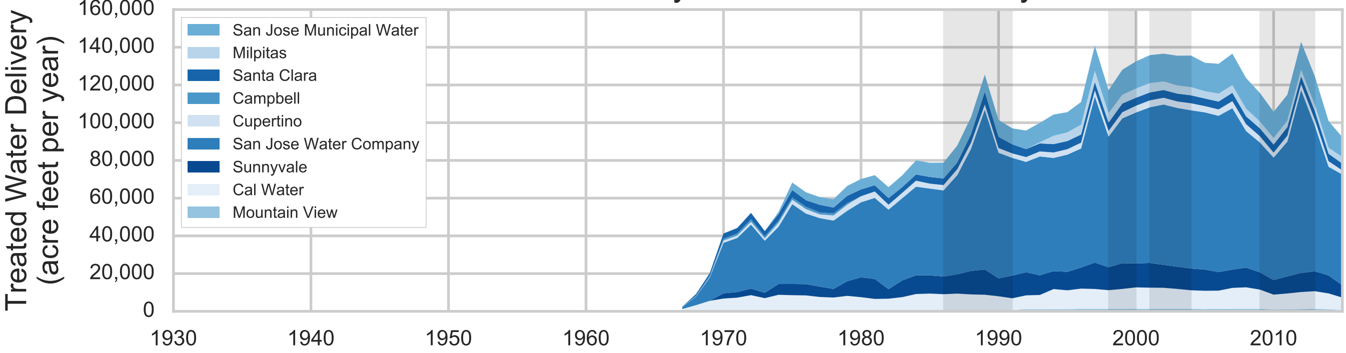
Cumulative Departure from Mean Annual Precipitation



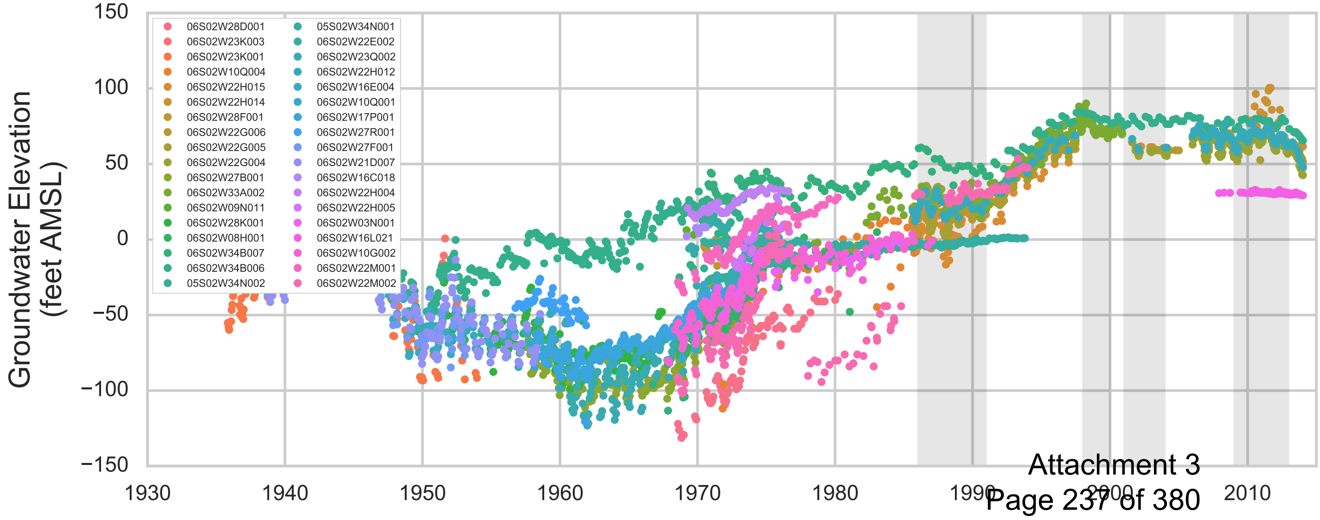
Groundwater Pumping in Mountain View: RWS Area



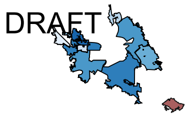
District Activity: Treated Water Delivery



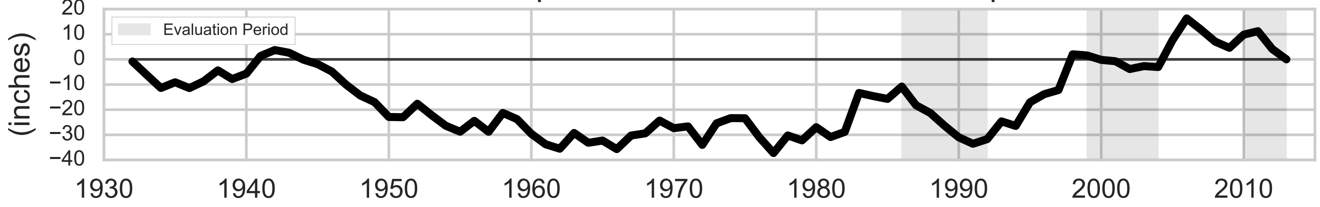
Observed Groundwater Elevations in Mountain View: RWS Area



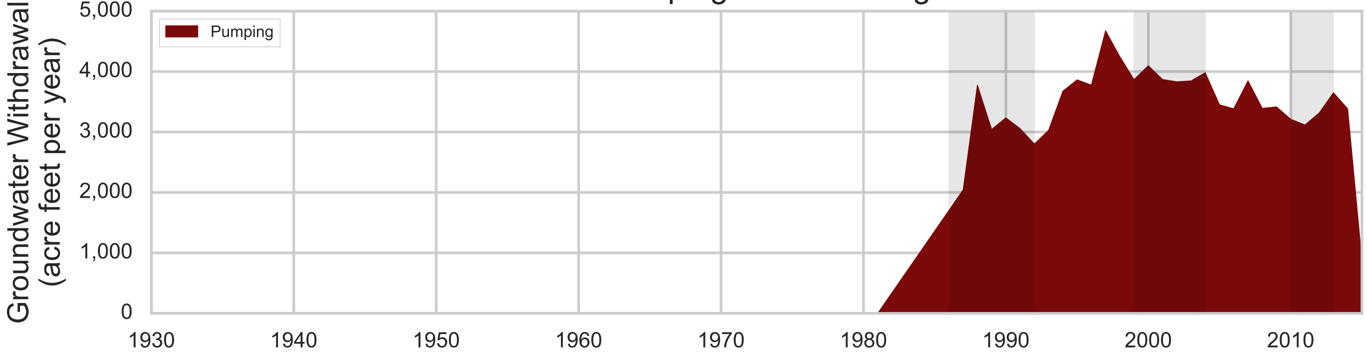
Pumping Area: North Morgan Hill:
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



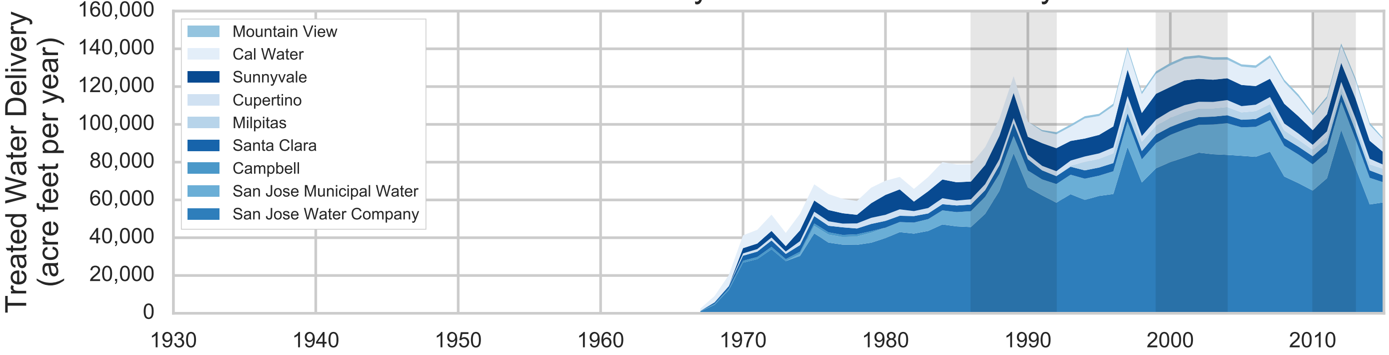
Cumulative Departure from Mean Annual Precipitation



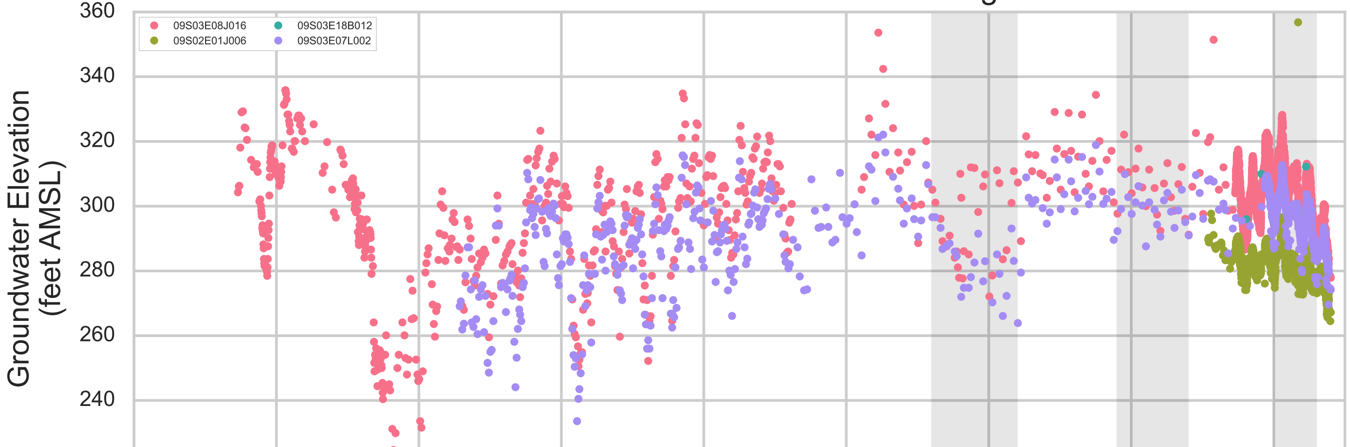
Groundwater Pumping in North Morgan Hill: Area



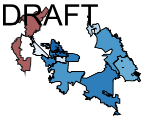
District Activity: Treated Water Delivery



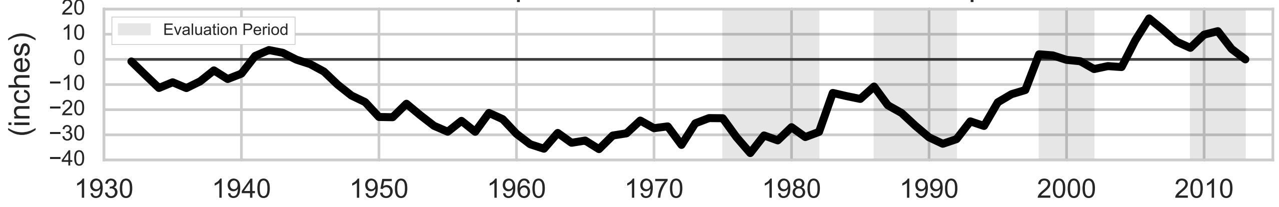
Observed Groundwater Elevations in North Morgan Hill: Area



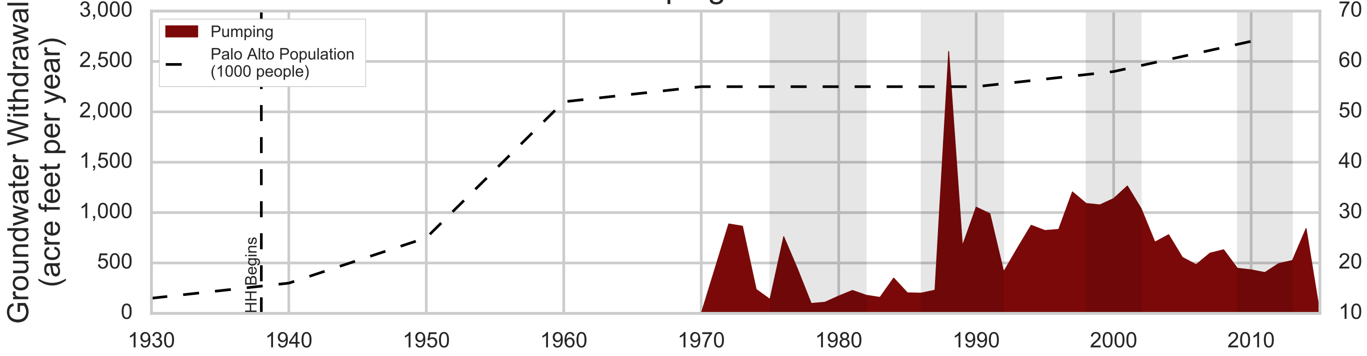
Pumping Area: Palo Alto: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



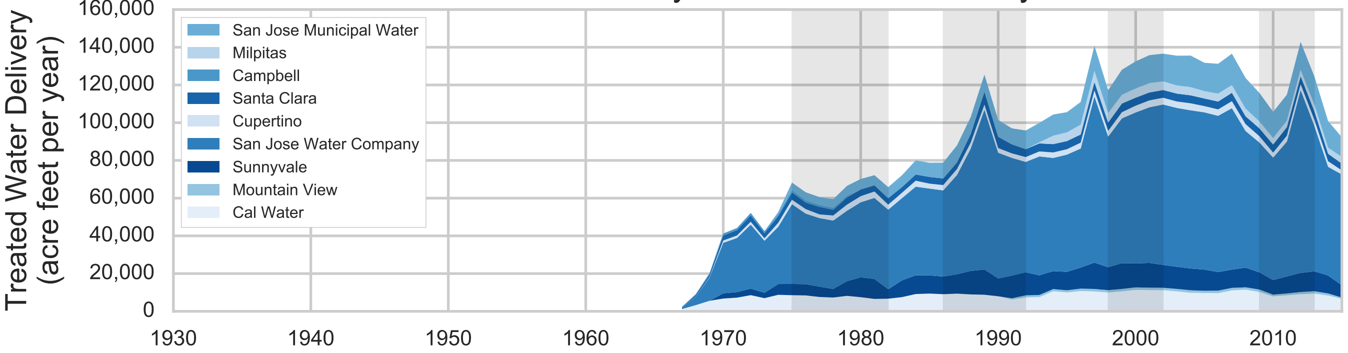
Cumulative Departure from Mean Annual Precipitation



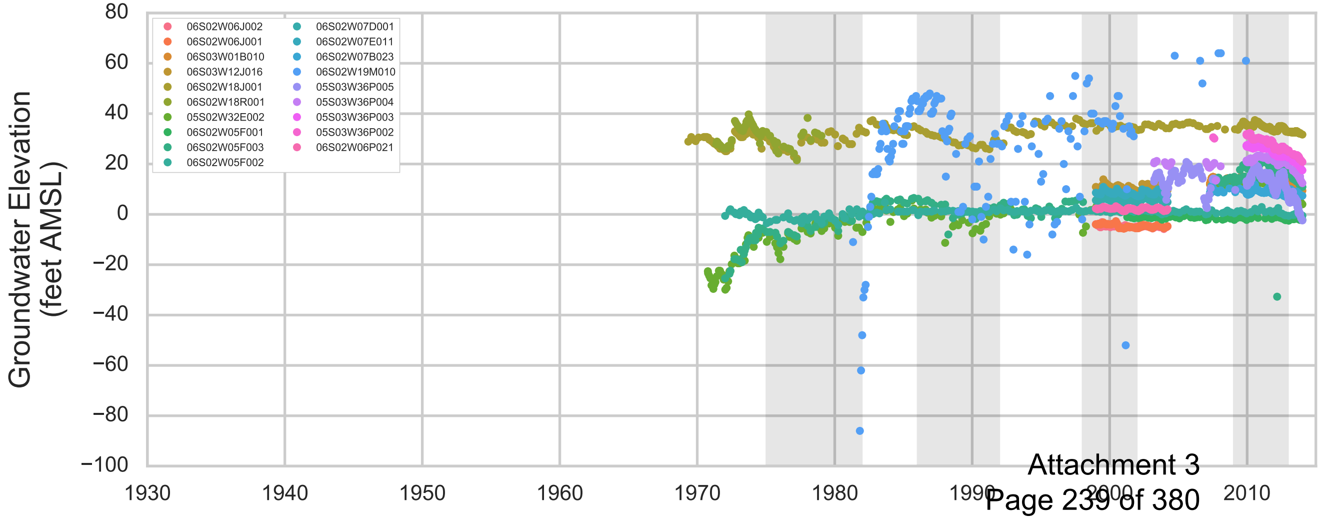
Groundwater Pumping in Palo Alto: RWS Area



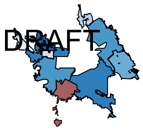
District Activity: Treated Water Delivery

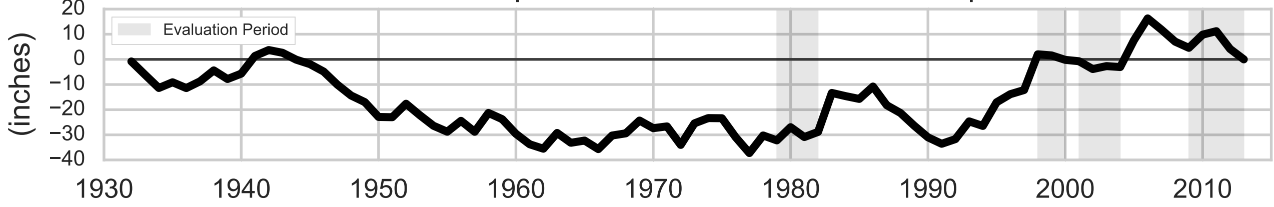


Observed Groundwater Elevations in Palo Alto: RWS Area

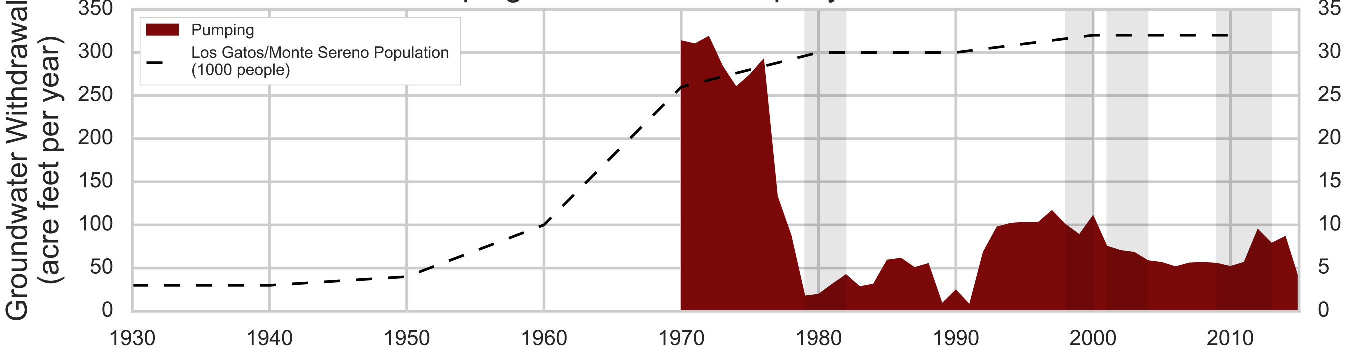


Pumping Area: SJ Water Company Los Gatos: Local SW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

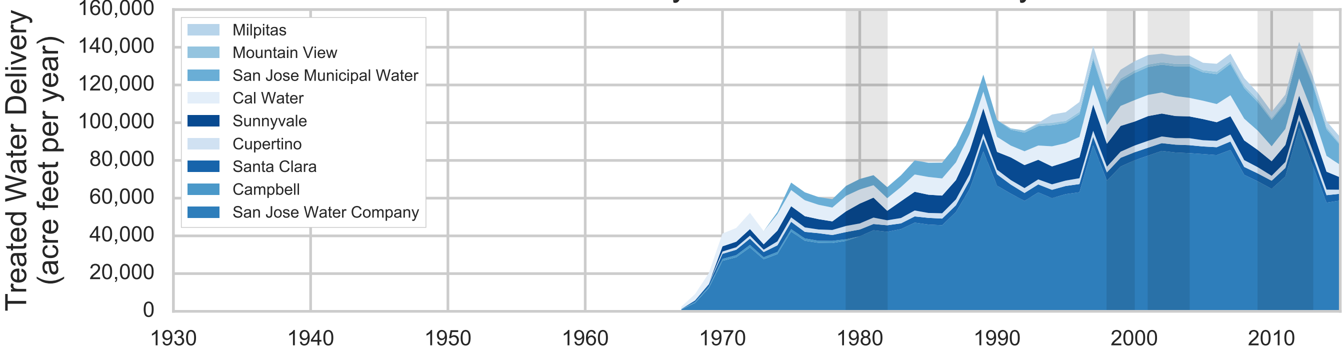




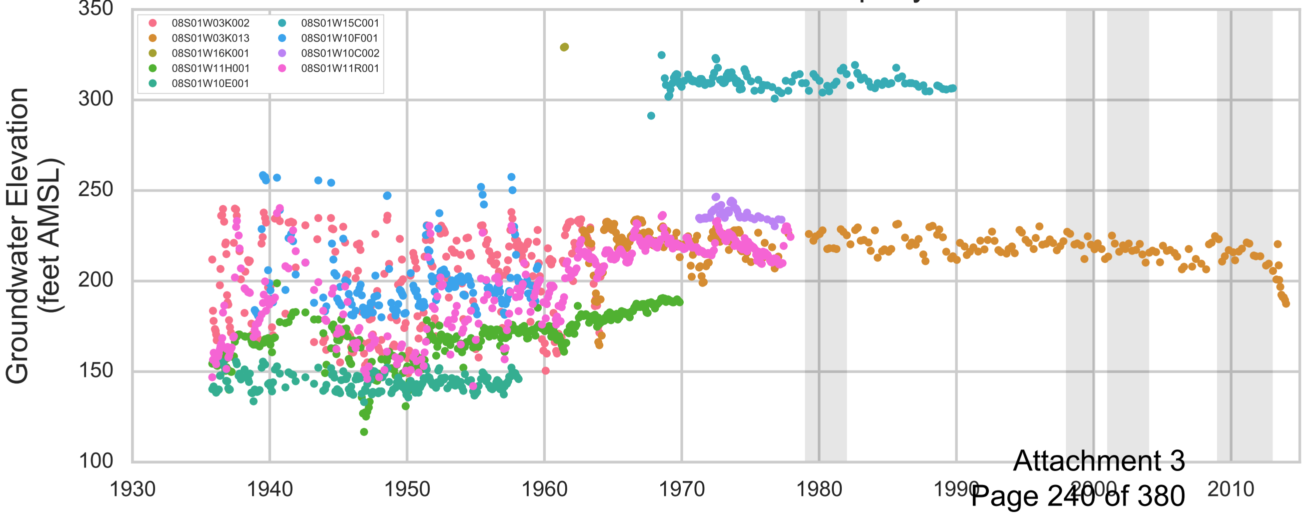
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in SJ Water Company Los Gatos: Local SW Area

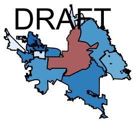


District Activity: Treated Water Delivery



Observed Groundwater Elevations in SJ Water Company Los Gatos: Local SW Area

Pumping Area: SJ Water Company North: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



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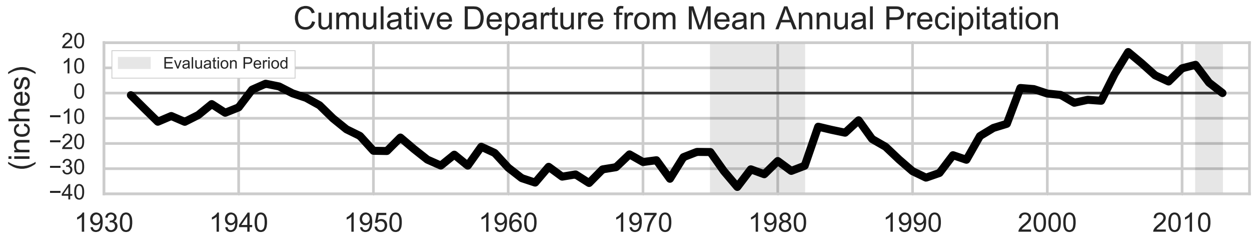
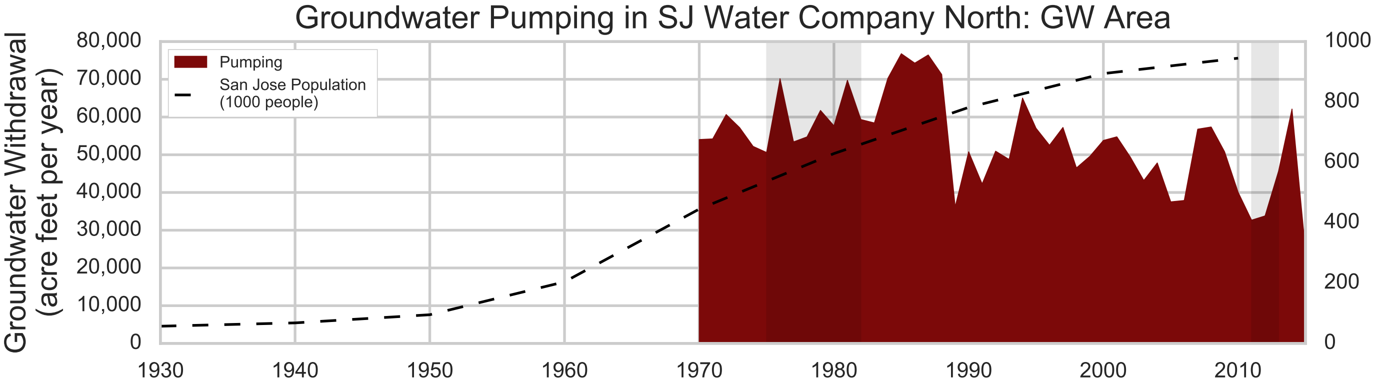
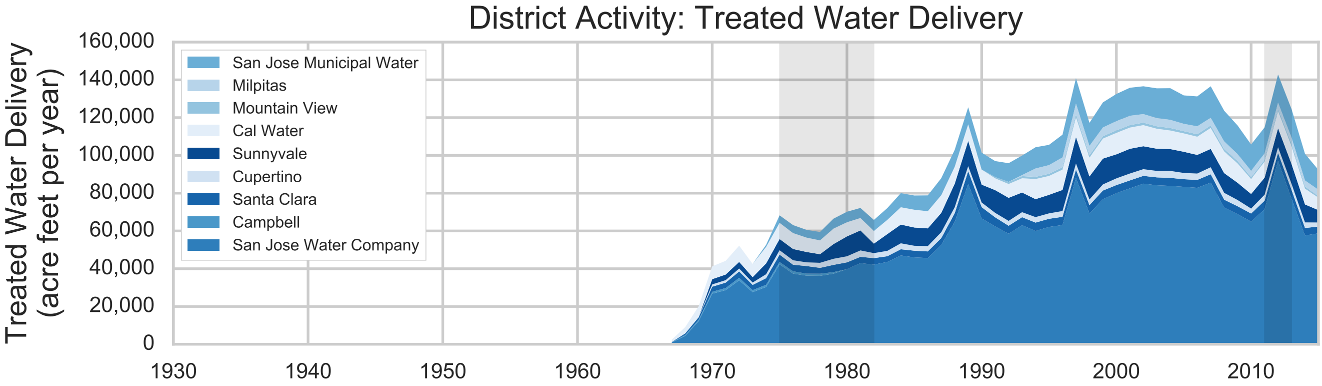


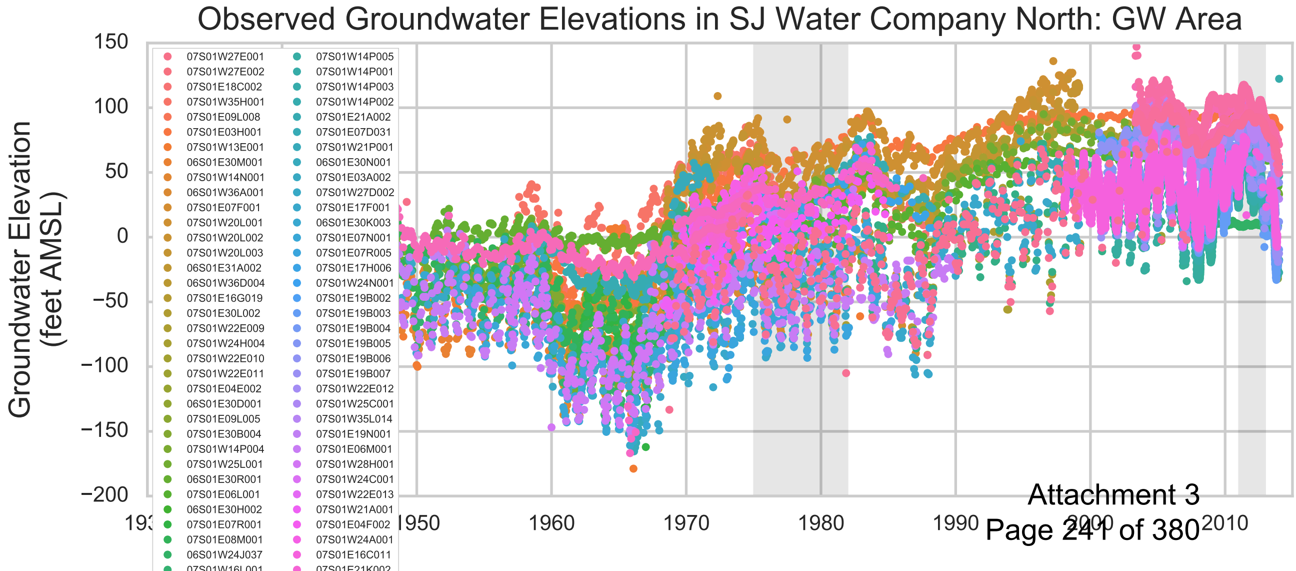
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in SJ Water Company North: GW Area



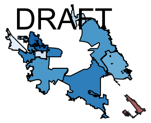
District Activity: Treated Water Delivery

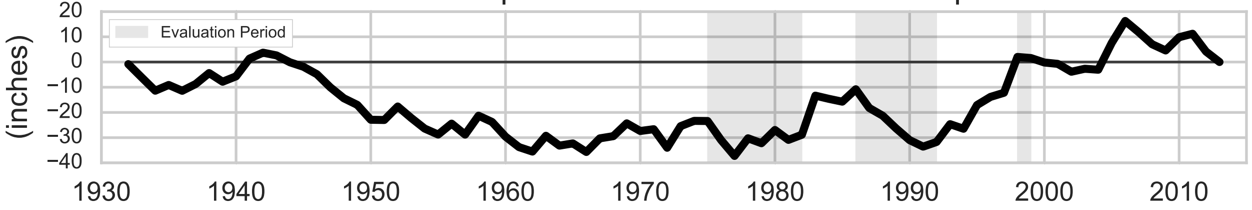


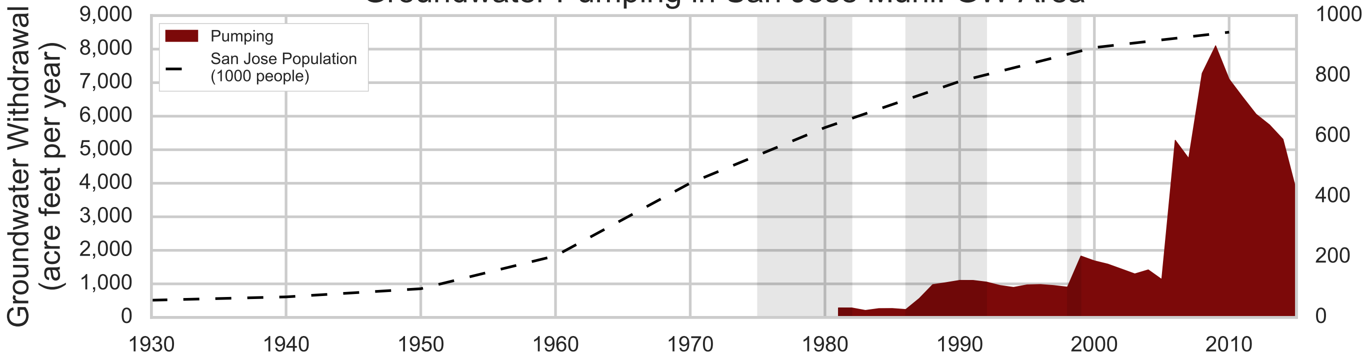
Observed Groundwater Elevations in SJ Water Company North: GW Area

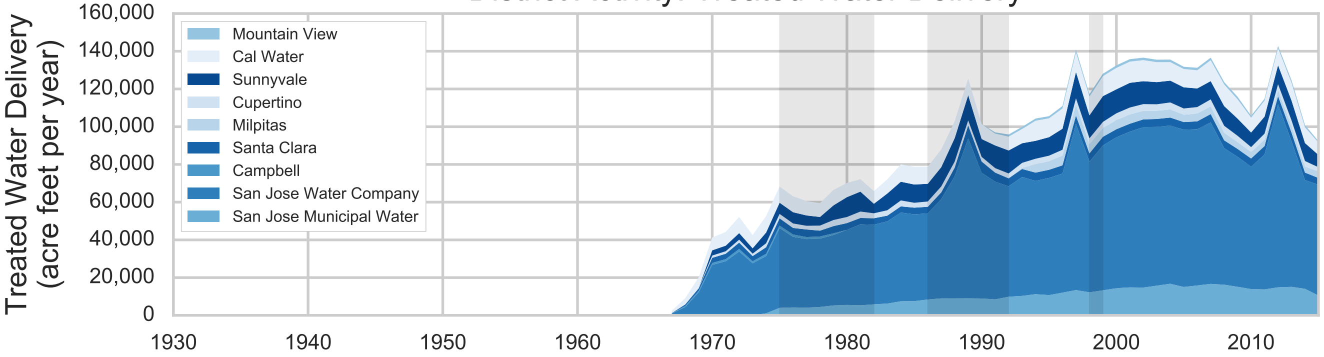
Pumping Area: San Jose Muni: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

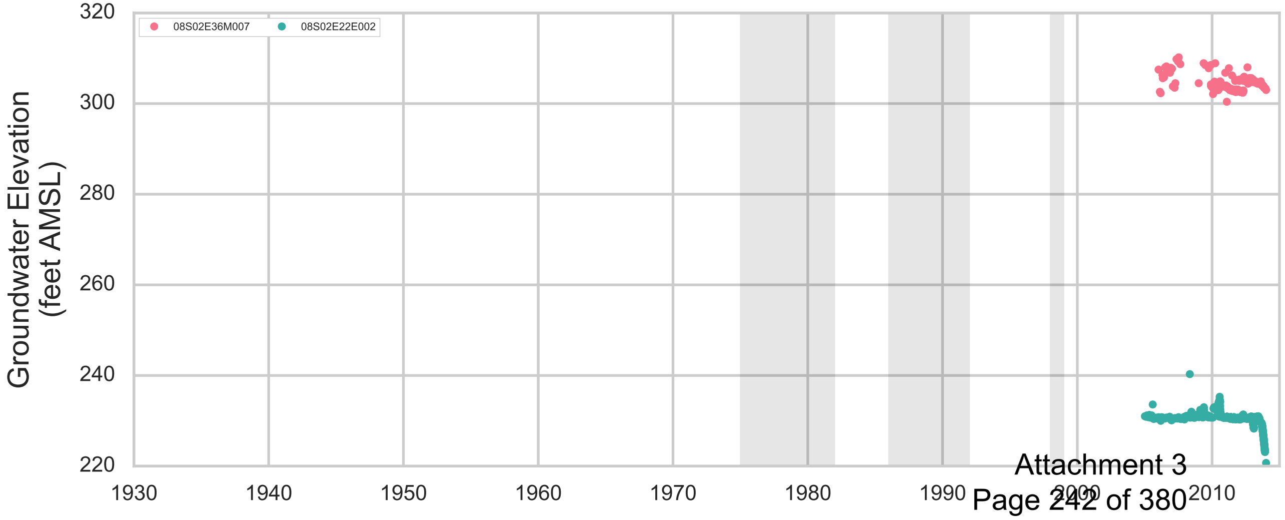
DRAFT




Cumulative Departure from Mean Annual Precipitation

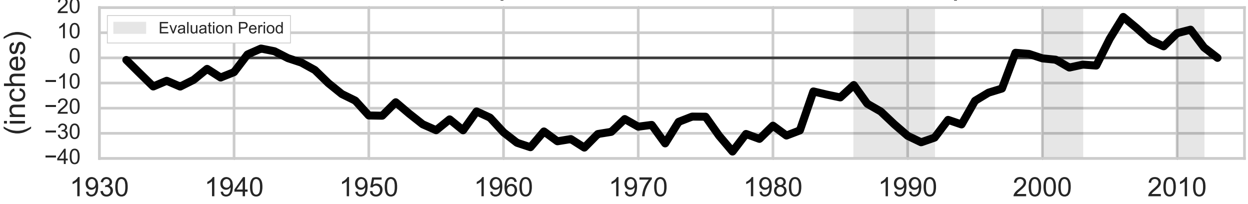

Groundwater Pumping in San Jose Muni: GW Area


District Activity: Treated Water Delivery

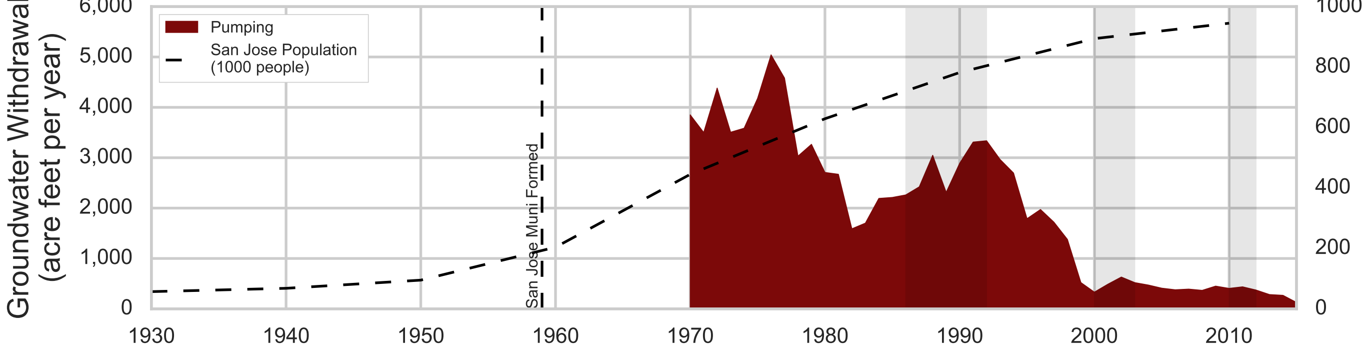

Observed Groundwater Elevations in San Jose Muni: GW Area

Pumping Area: San Jose Muni: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

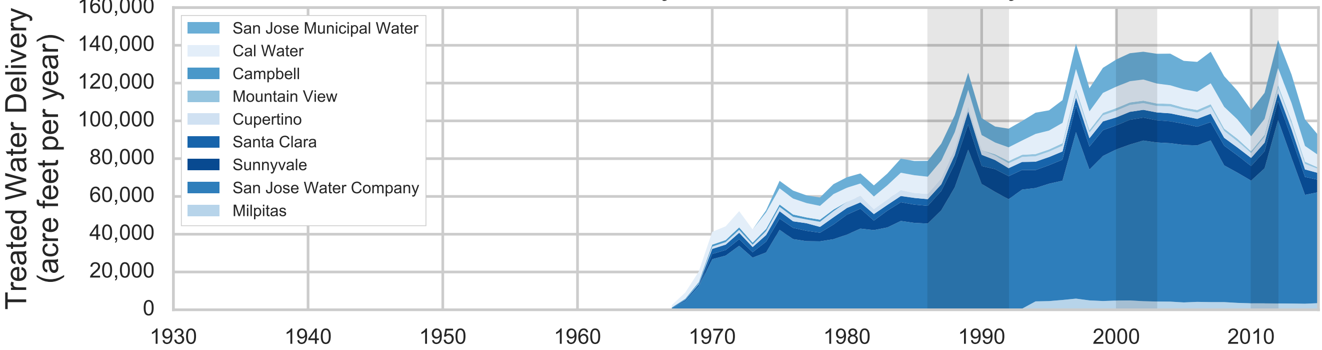
DRAFT



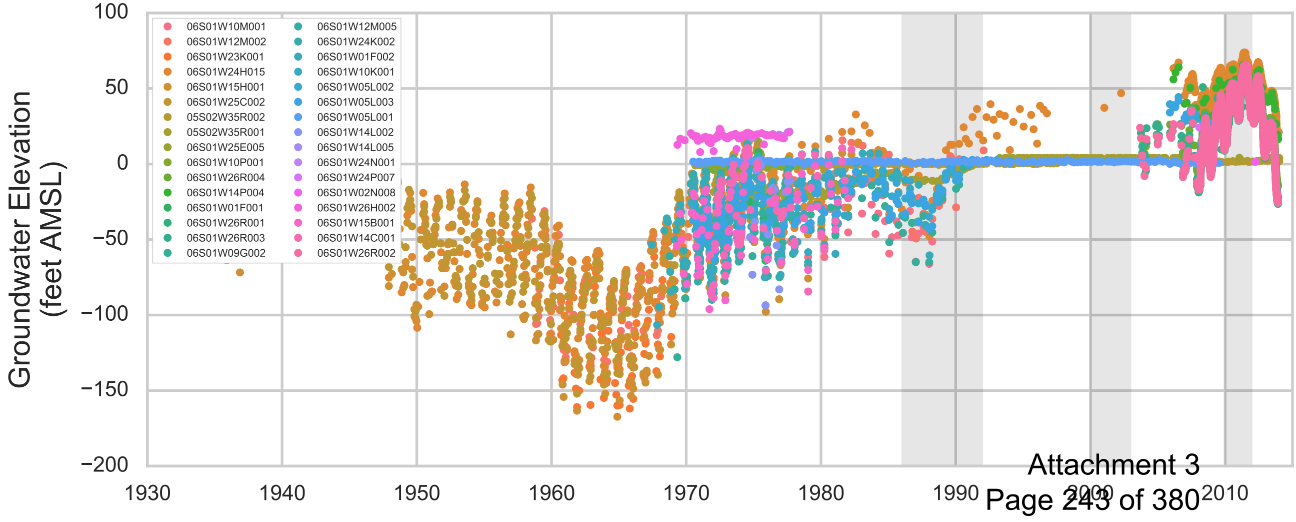
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in San Jose Muni: RWS Area

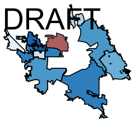


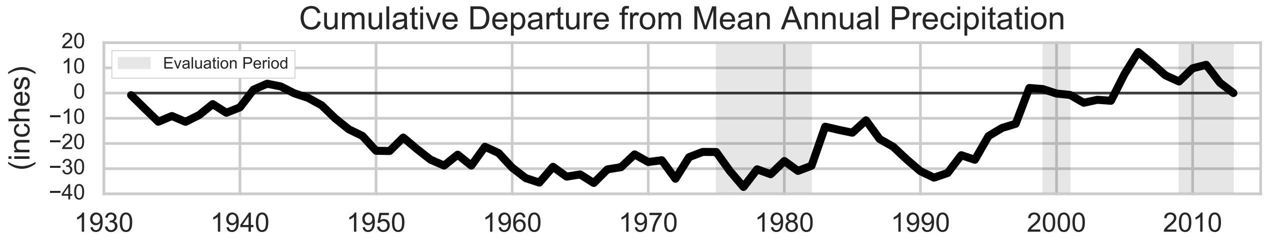
District Activity: Treated Water Delivery

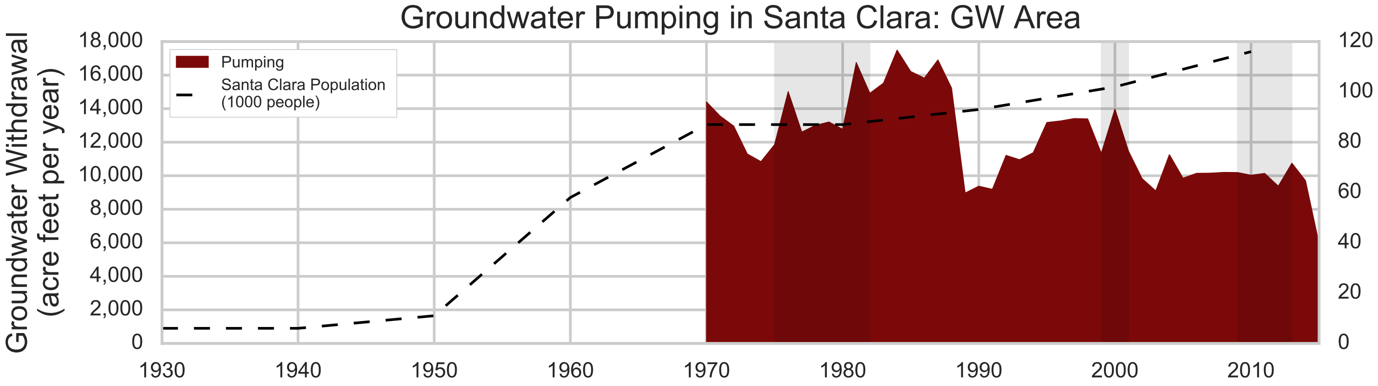


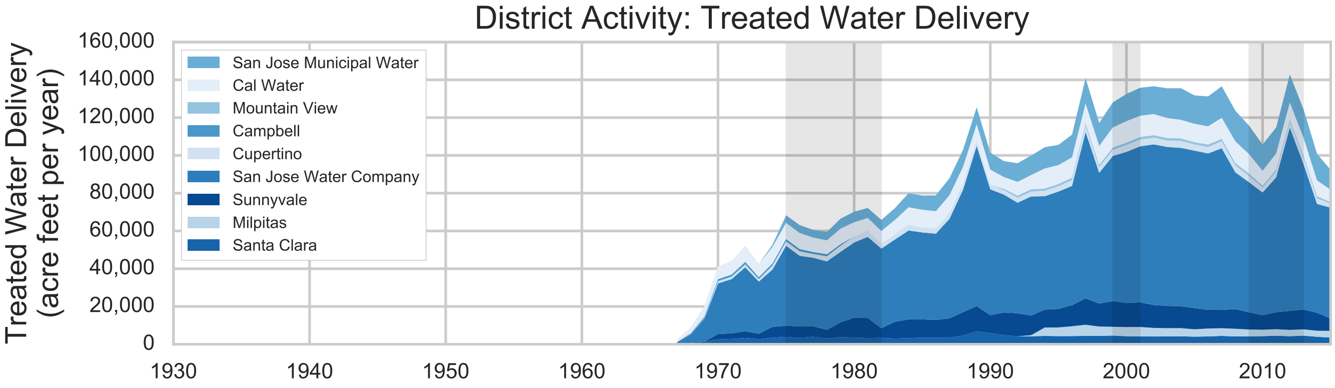
Observed Groundwater Elevations in San Jose Muni: RWS Area

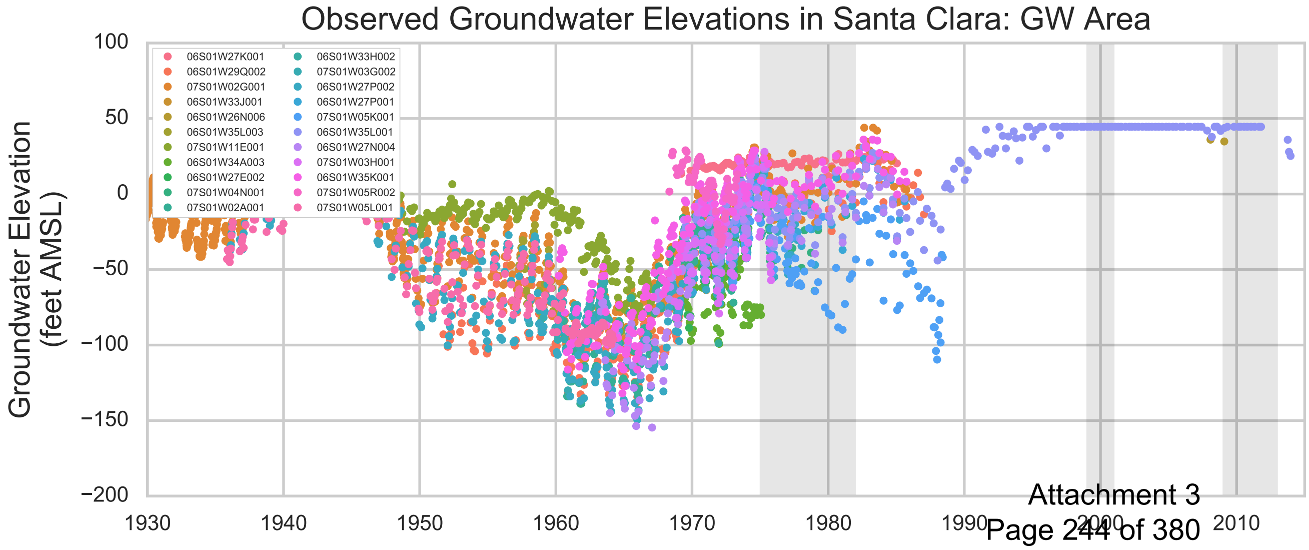
Pumping Area: Santa Clara: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



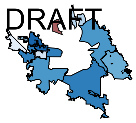

Cumulative Departure from Mean Annual Precipitation


Groundwater Pumping in Santa Clara: GW Area

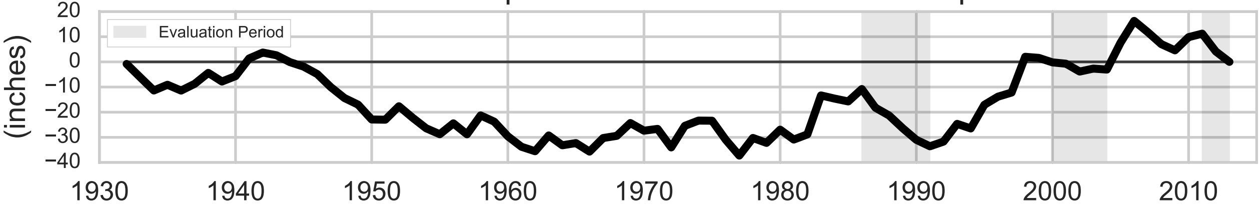

District Activity: Treated Water Delivery


Observed Groundwater Elevations in Santa Clara: GW Area

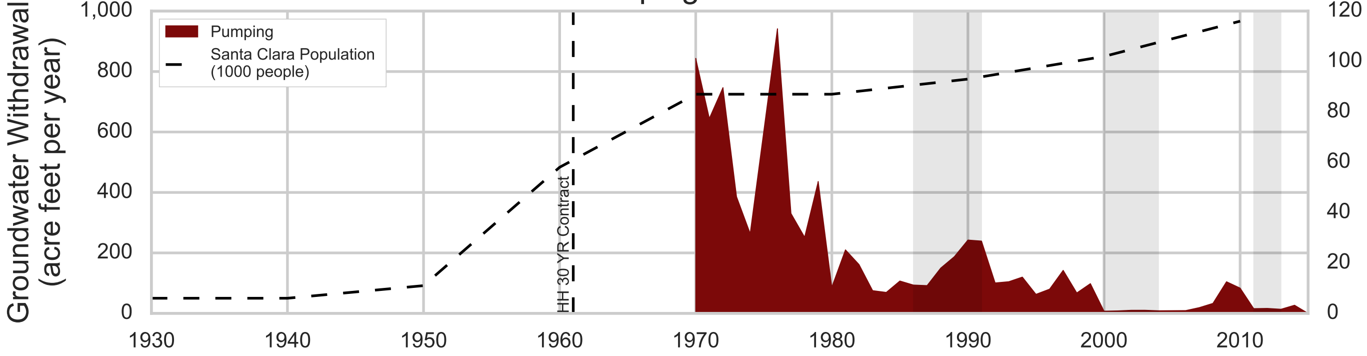
Pumping Area: Santa Clara: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells



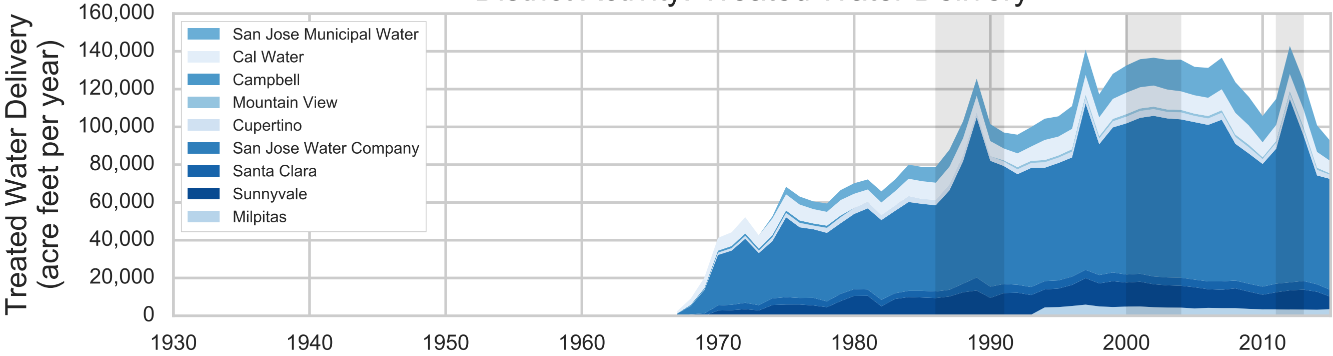
Cumulative Departure from Mean Annual Precipitation



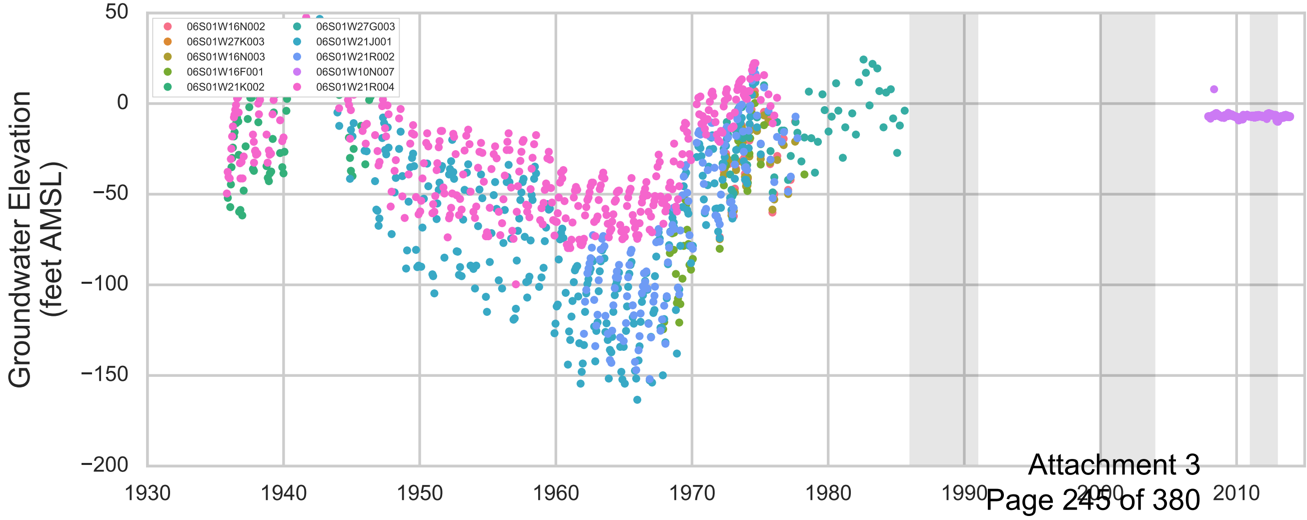
Groundwater Pumping in Santa Clara: RWS Area



District Activity: Treated Water Delivery



Observed Groundwater Elevations in Santa Clara: RWS Area



Pumping Area: Santa Clara: RWS GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

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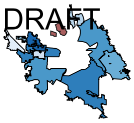
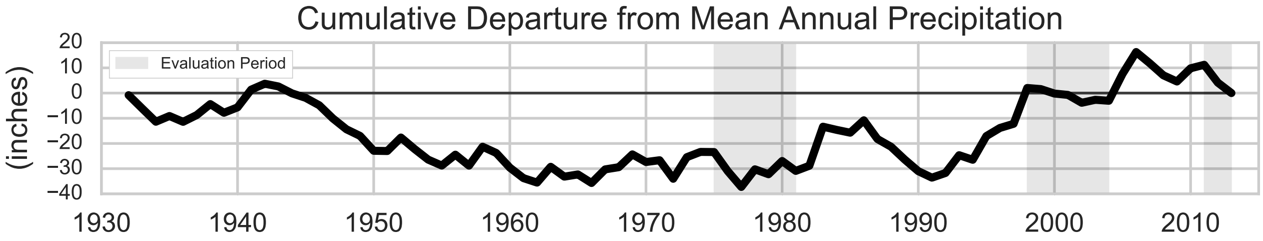
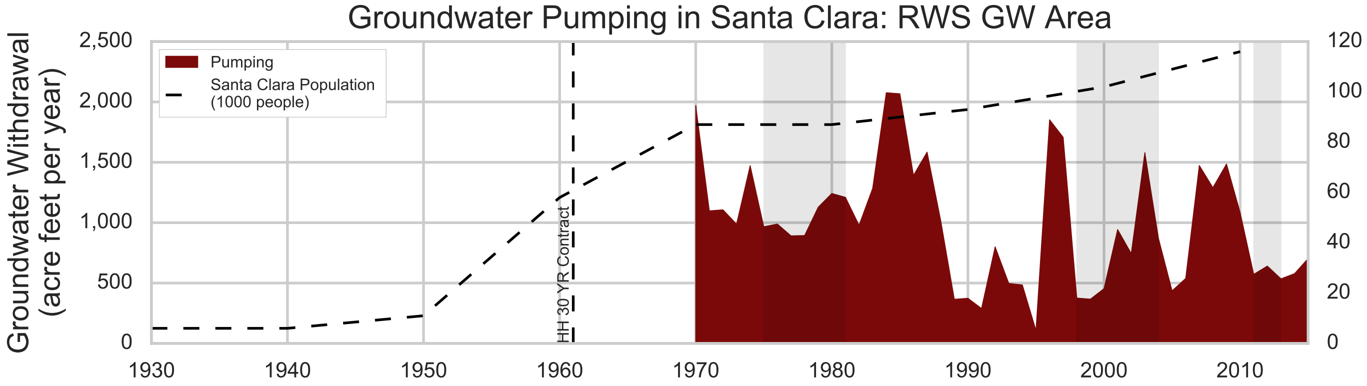
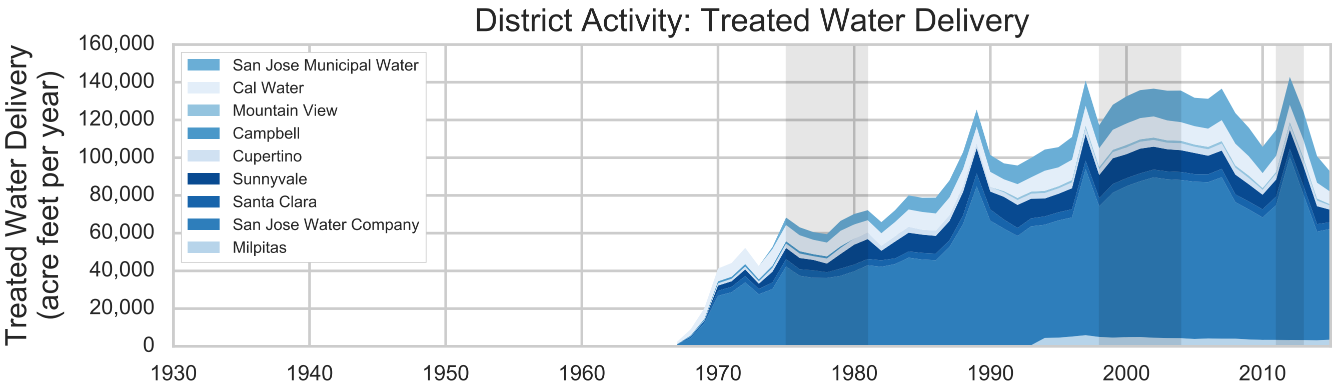
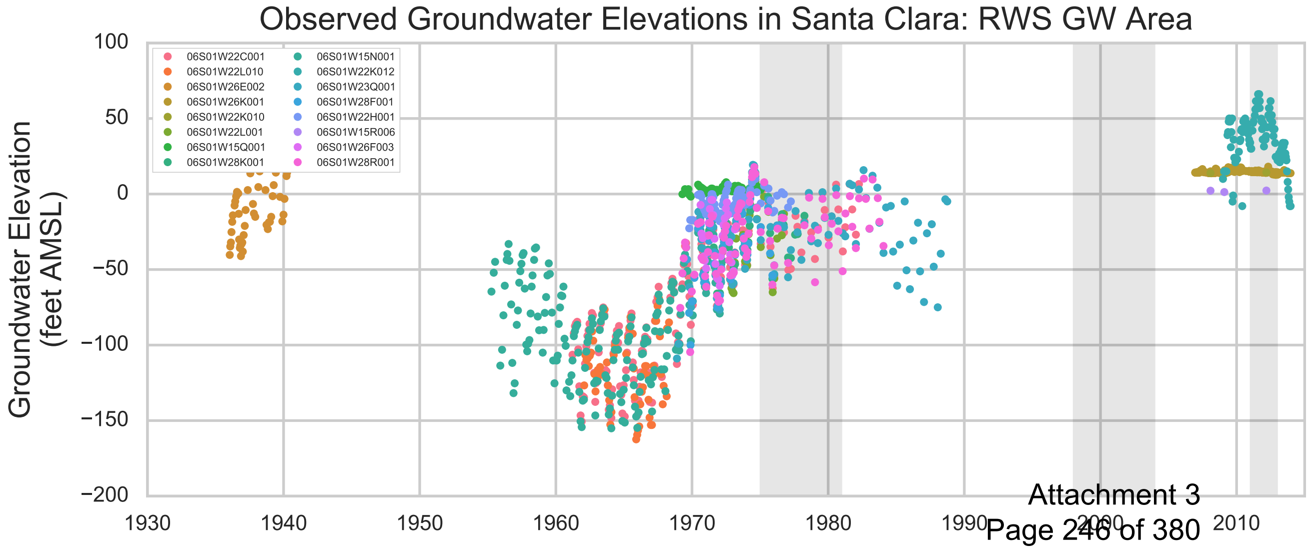



Cumulative Departure from Mean Annual Precipitation

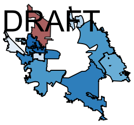

Groundwater Pumping in Santa Clara: RWS GW Area

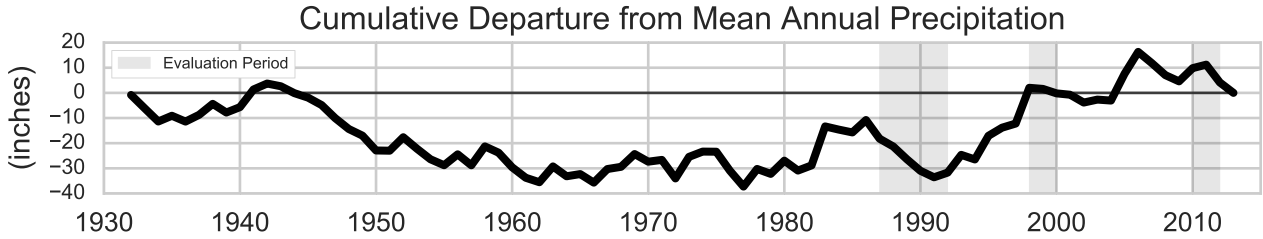

District Activity: Treated Water Delivery

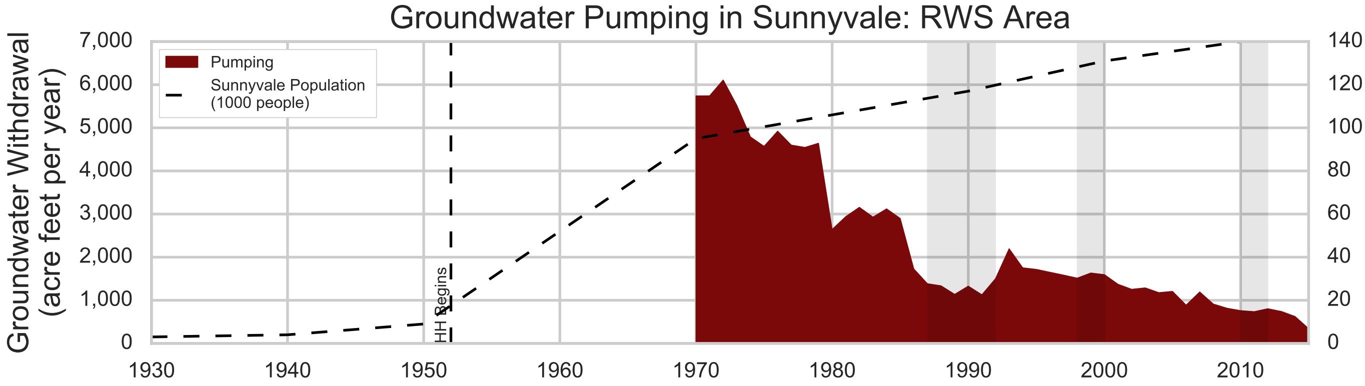

Observed Groundwater Elevations in Santa Clara: RWS GW Area

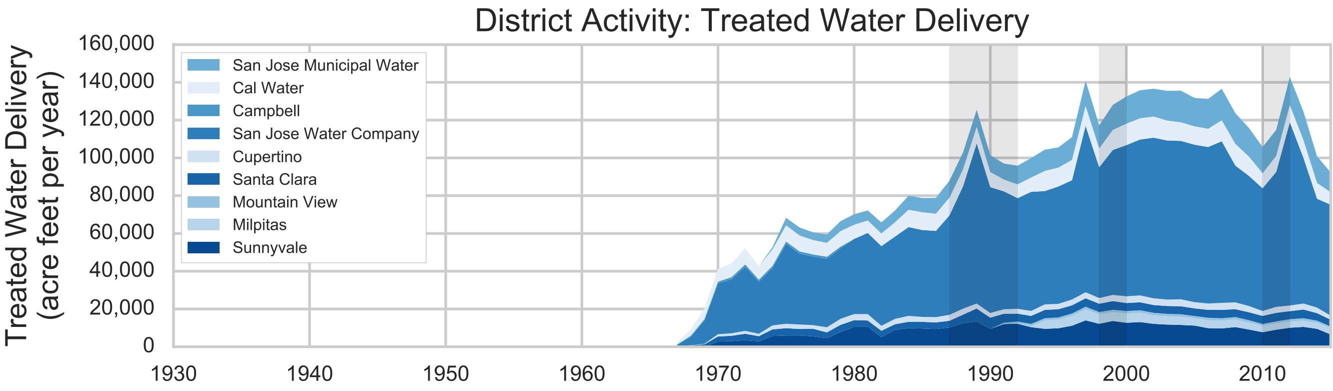
Pumping Area: Sunnyvale: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitoring Wells

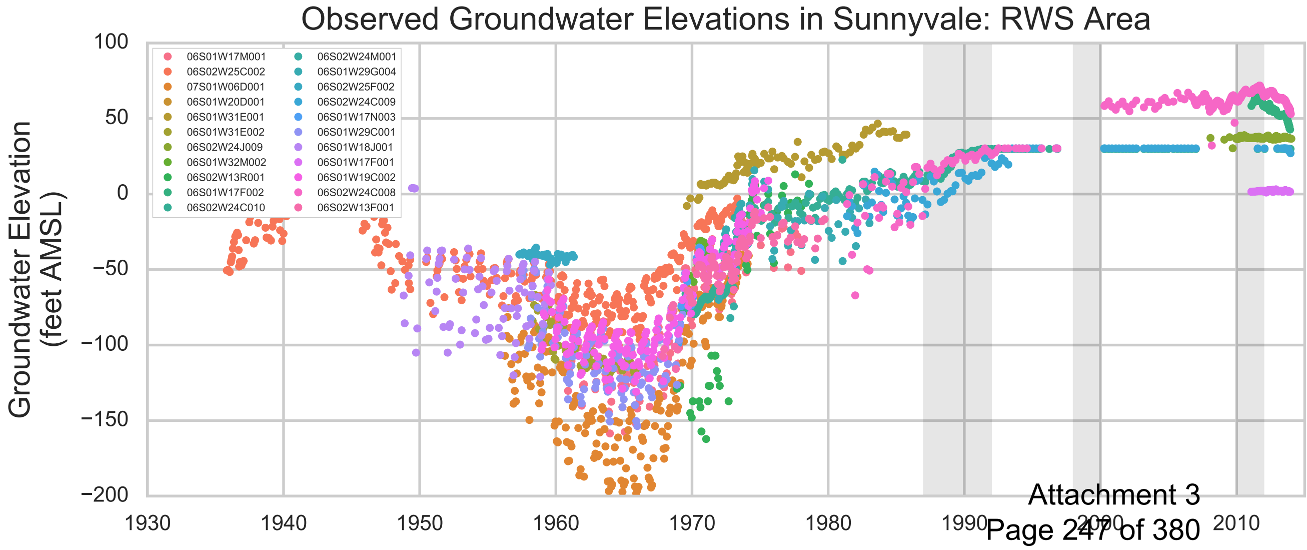
DRAFT









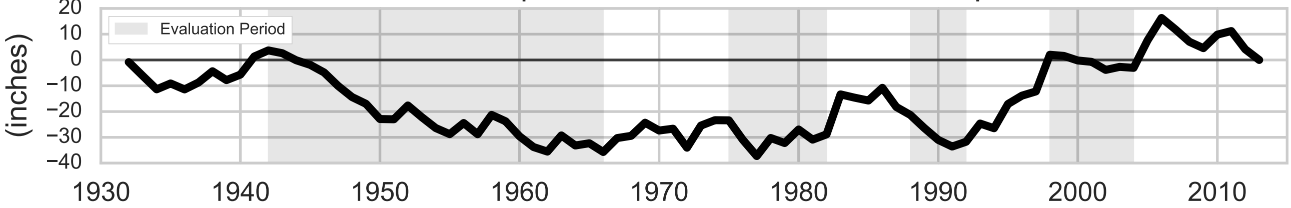


Appendix E

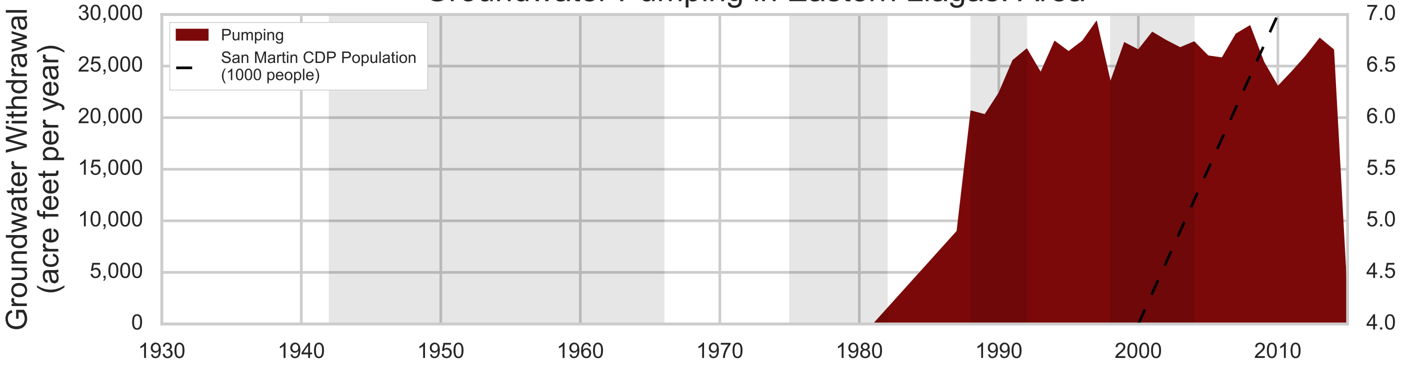
Groundwater Level Trends in Monitoring Wells to Evaluate Benefits from Managed Aquifer Recharge in Llagas Subbasin

Pumping Area: Eastern Llagas:
Activity: Llagas Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

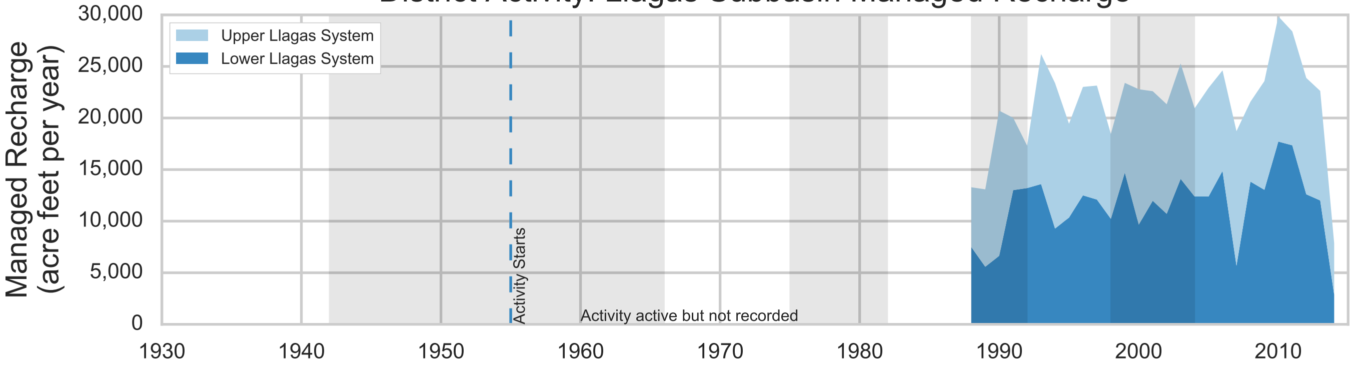
Cumulative Departure from Mean Annual Precipitation



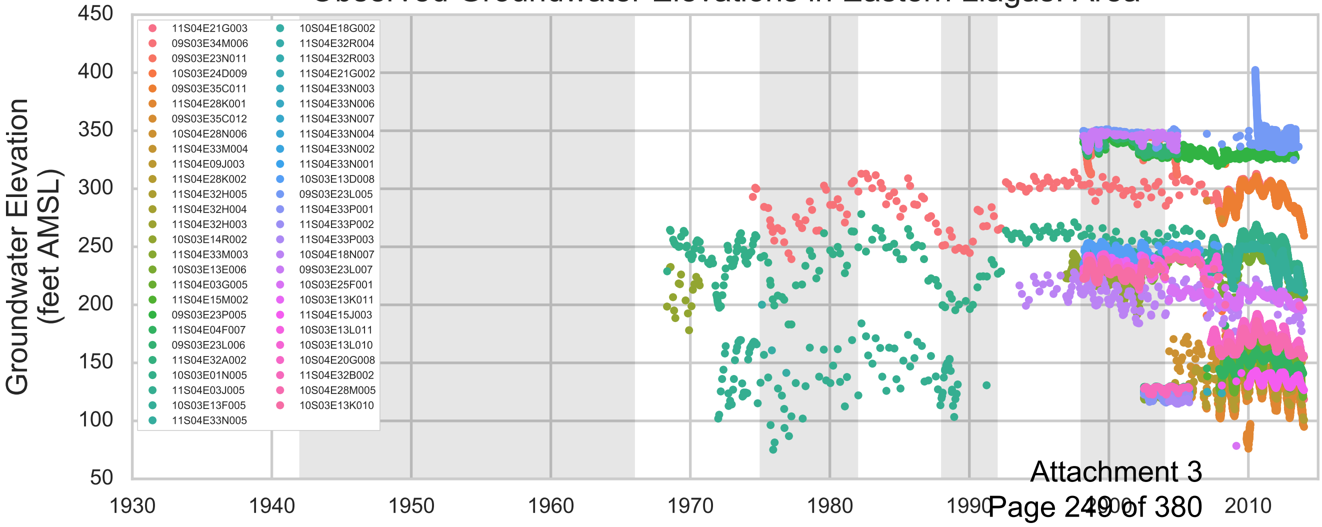
Groundwater Pumping in Eastern Llagas: Area



District Activity: Llagas Subbasin Managed Recharge

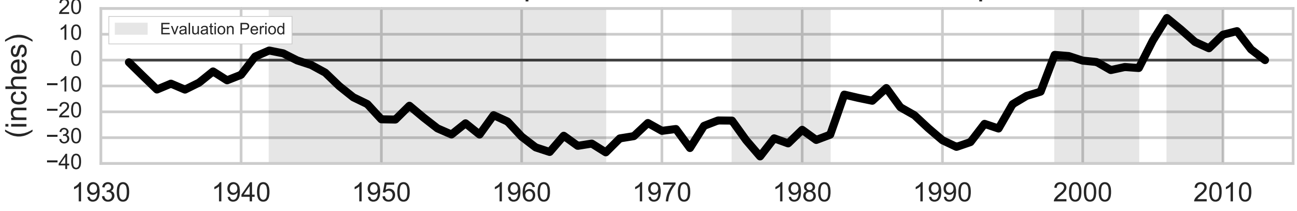


Observed Groundwater Elevations in Eastern Llagas: Area

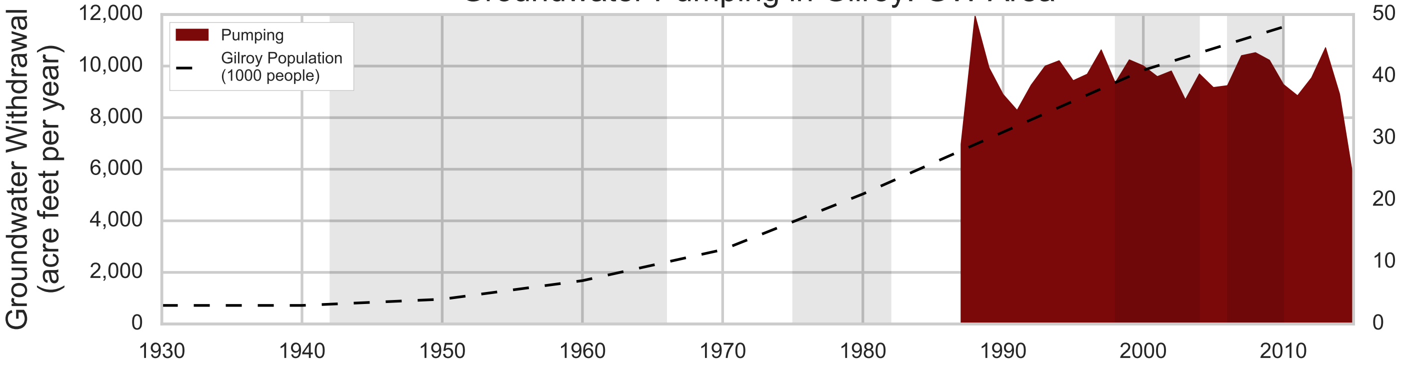


Pumping Area: Gilroy: GW
Activity: Llagas Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

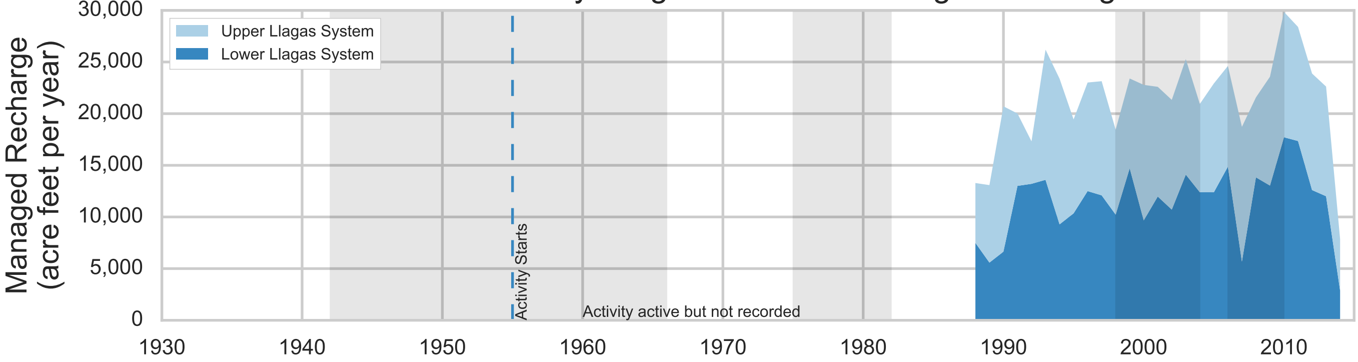
Cumulative Departure from Mean Annual Precipitation



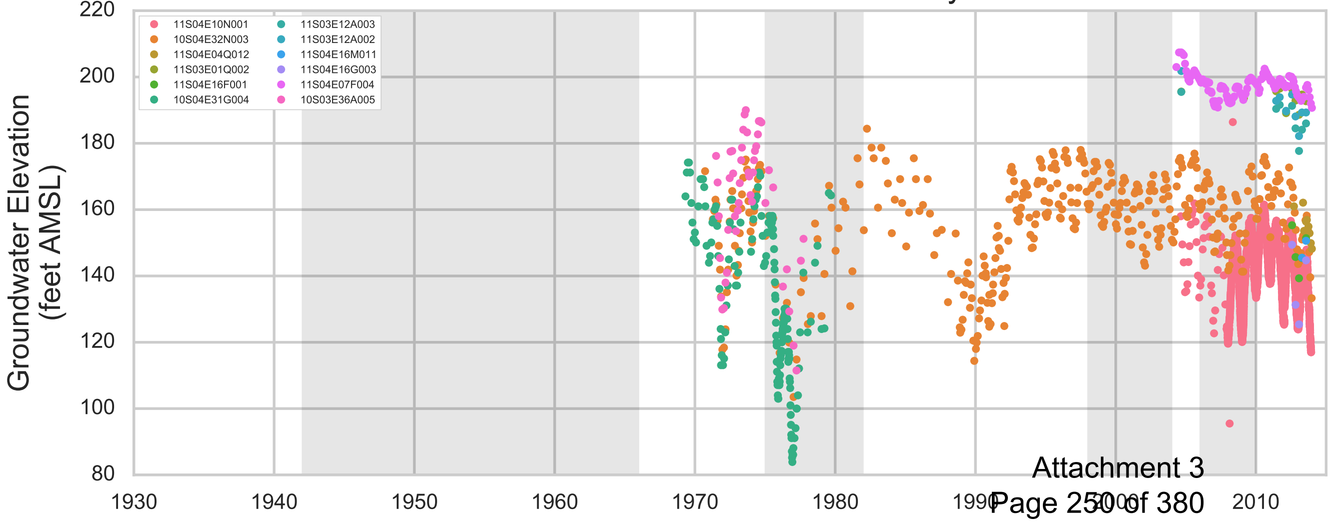
Groundwater Pumping in Gilroy: GW Area



District Activity: Llagas Subbasin Managed Recharge



Observed Groundwater Elevations in Gilroy: GW Area



Pumping Area: Morgan Hill: GW
Activity: Llagas Subbasin Managed Recharge
Groundwater Level Data from: Monitoring Wells

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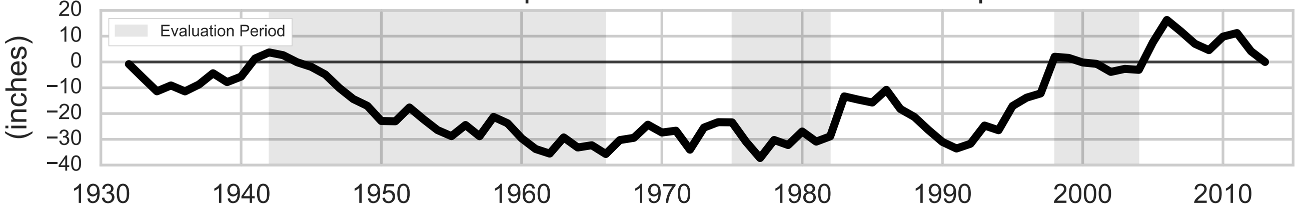
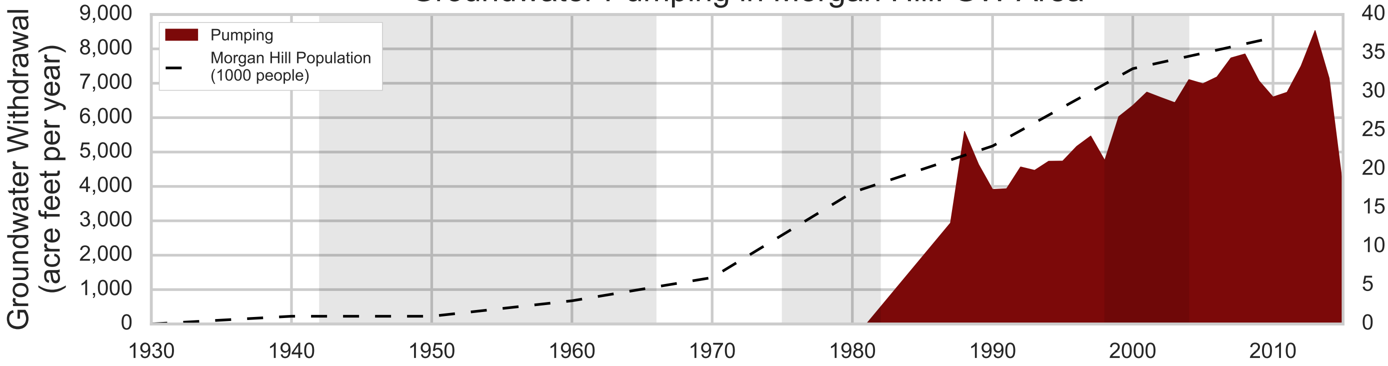
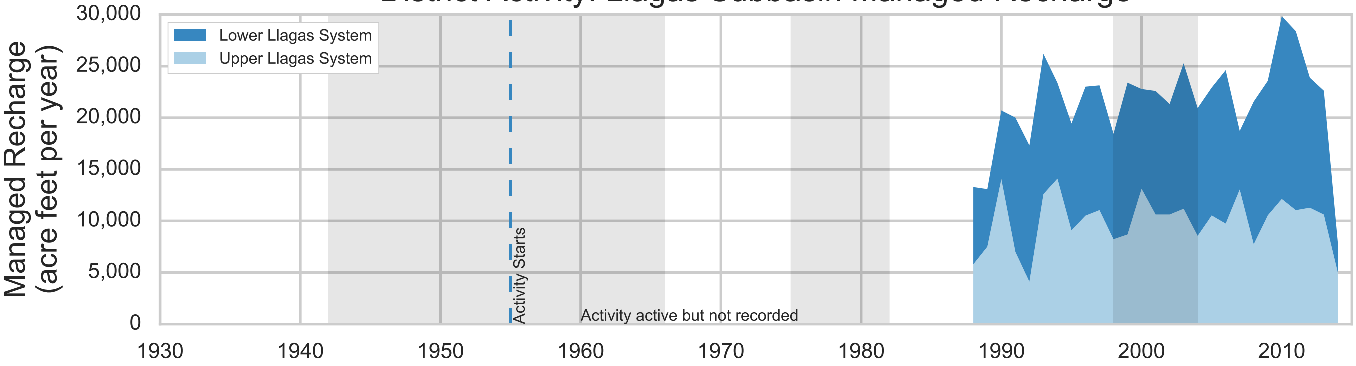
Cumulative Departure from Mean Annual Precipitation



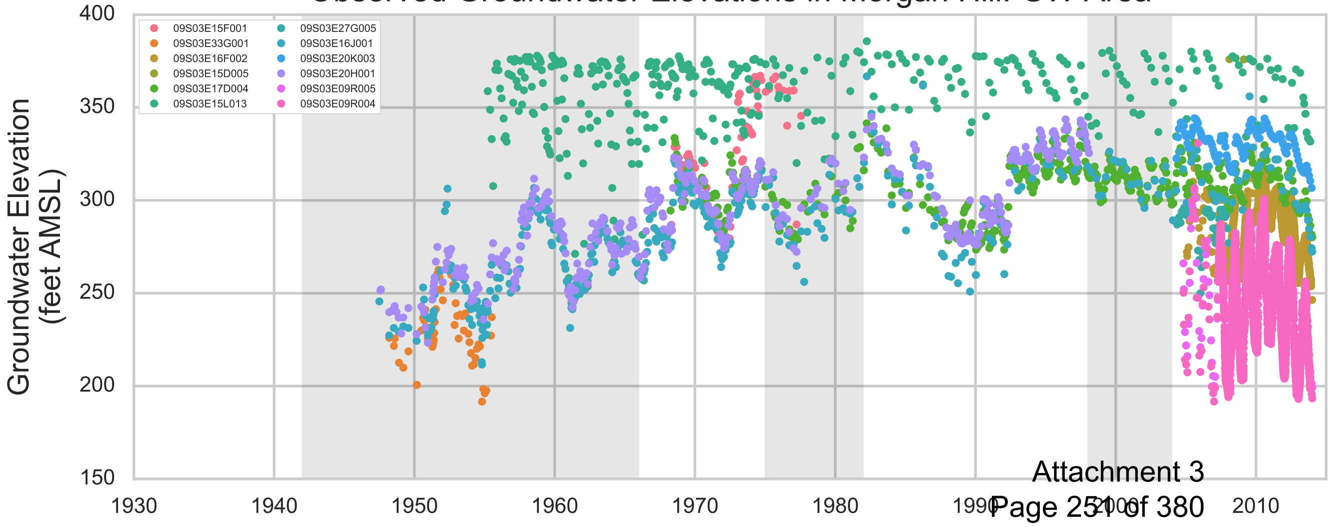
Groundwater Pumping in Morgan Hill: GW Area



District Activity: Llagas Subbasin Managed Recharge



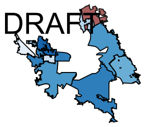
Observed Groundwater Elevations in Morgan Hill: GW Area

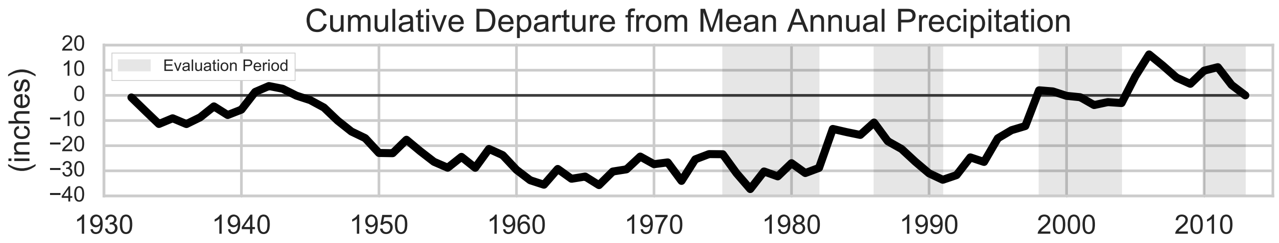


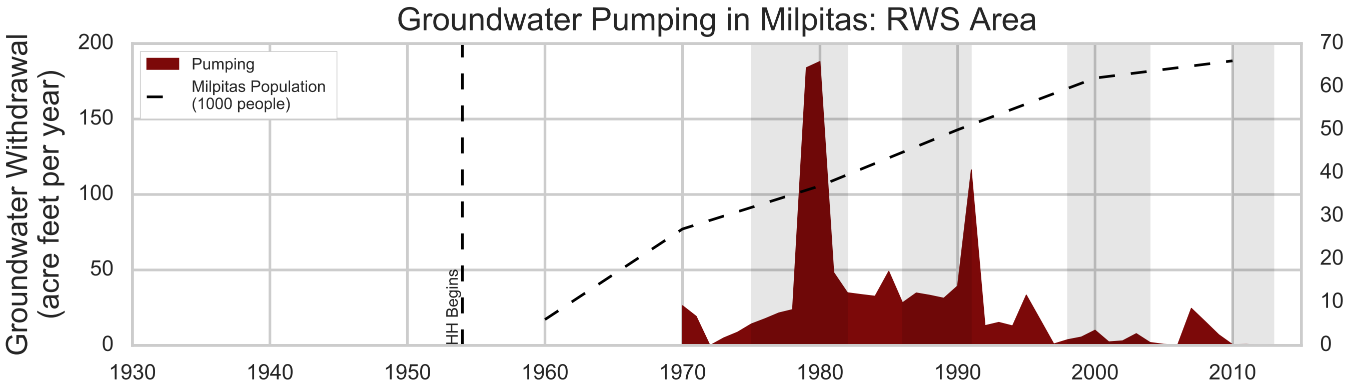
Appendix F

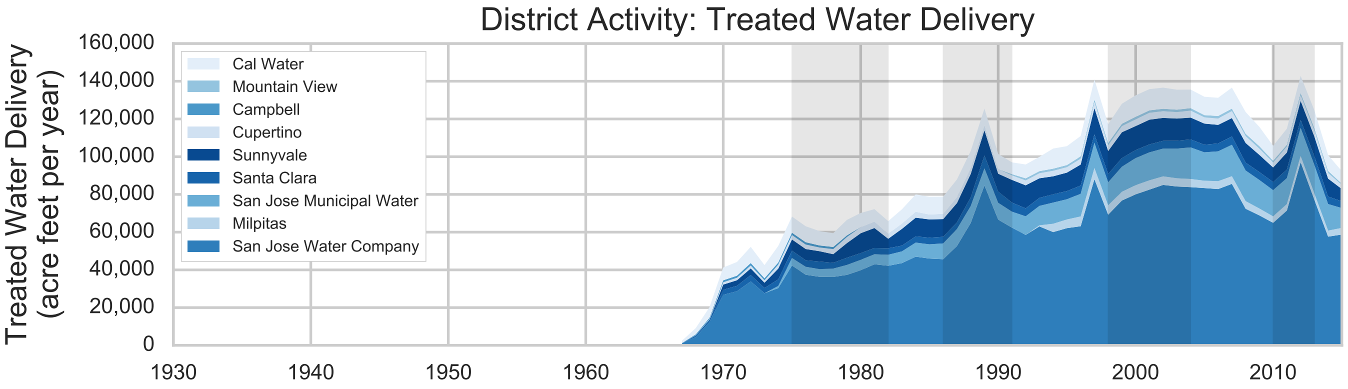
Groundwater Level Trends in Production Wells to Evaluate Benefits from District Activities in Select Pumping Areas

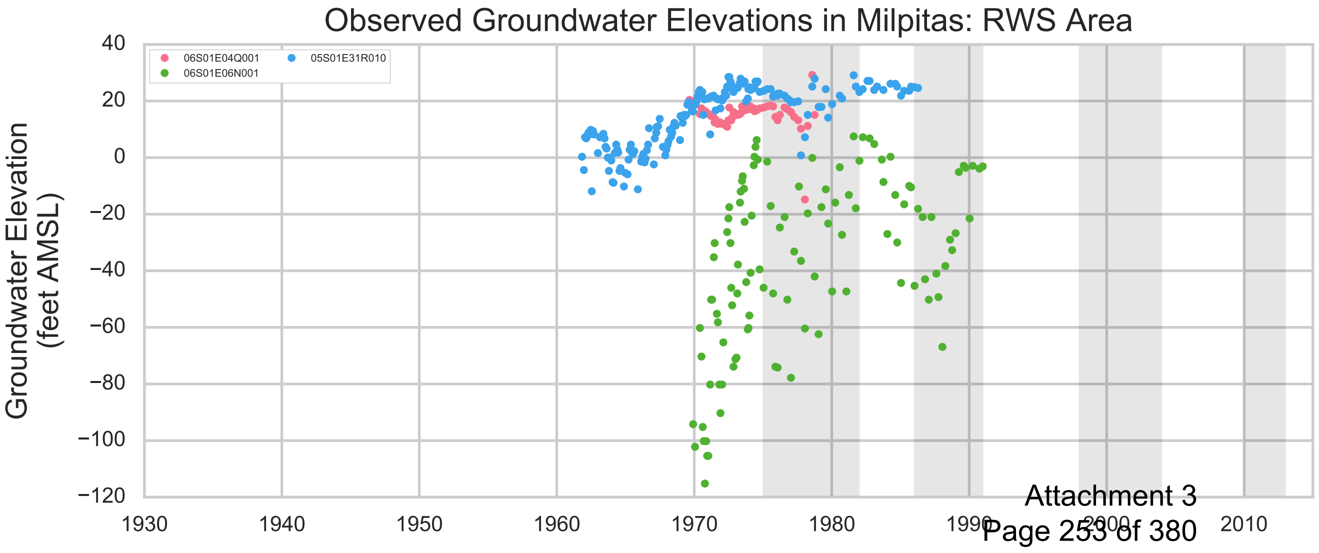
Pumping Area: Milpitas: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitored Pumping Wells



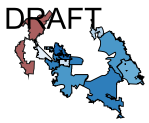

Cumulative Departure from Mean Annual Precipitation


Groundwater Pumping in Milpitas: RWS Area

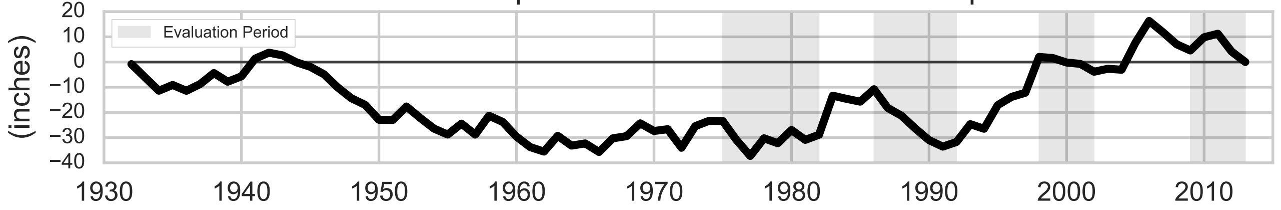

District Activity: Treated Water Delivery


Observed Groundwater Elevations in Milpitas: RWS Area

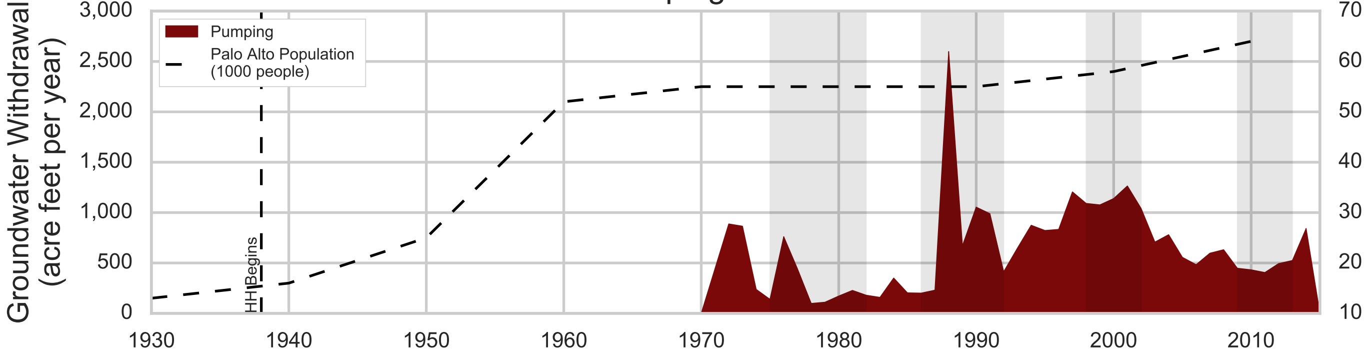
Pumping Area: Palo Alto: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitored Pumping Wells



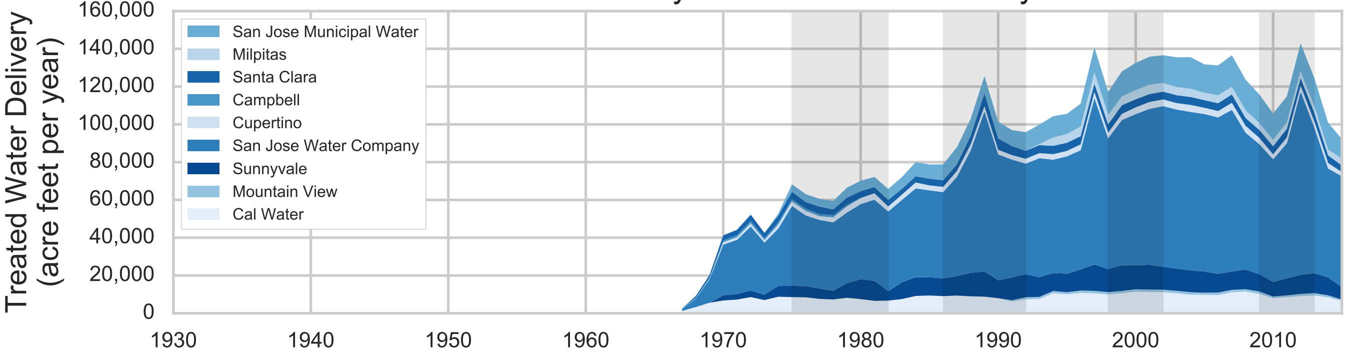
Cumulative Departure from Mean Annual Precipitation



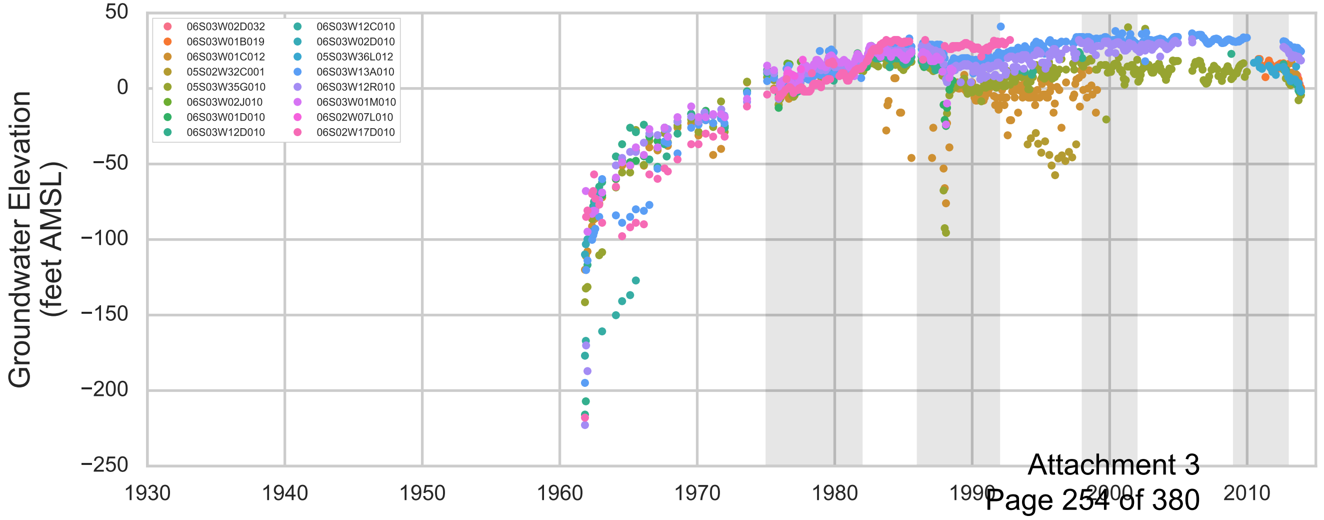
Groundwater Pumping in Palo Alto: RWS Area



District Activity: Treated Water Delivery



Observed Groundwater Elevations in Palo Alto: RWS Area



Pumping Area: SJ Water Company Los Gatos: Local SW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitored Pumping Wells

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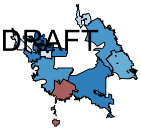
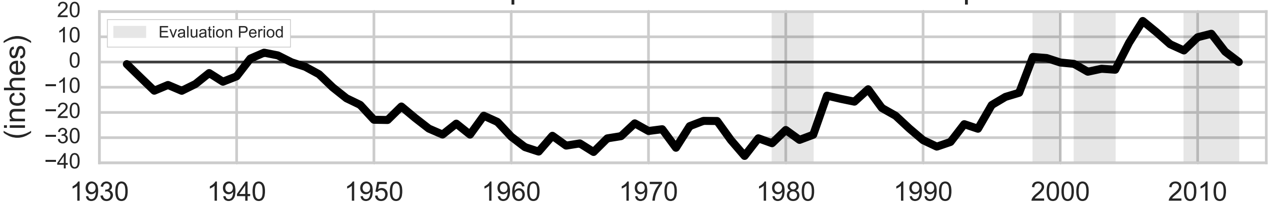
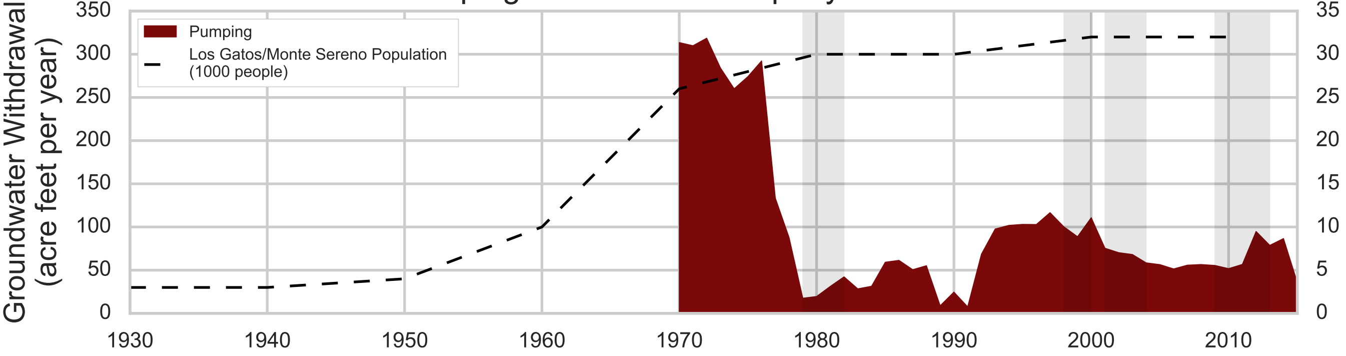


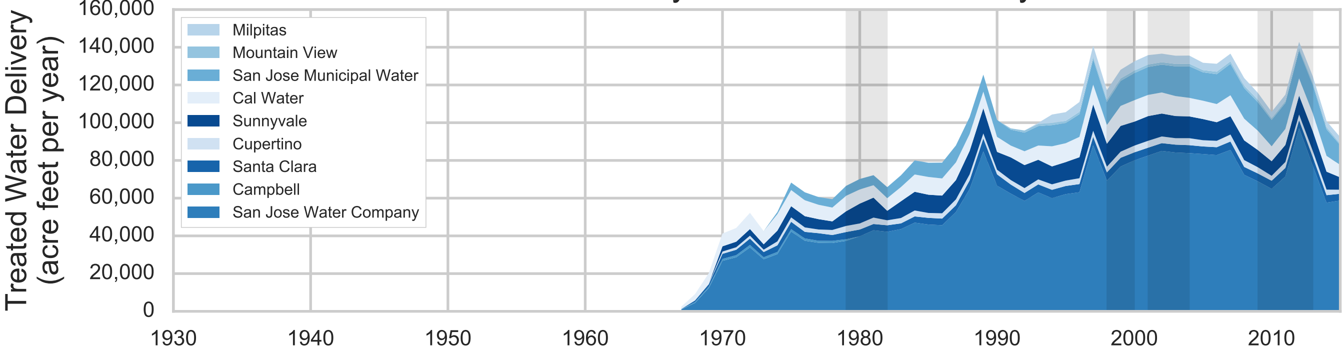
Cumulative Departure from Mean Annual Precipitation



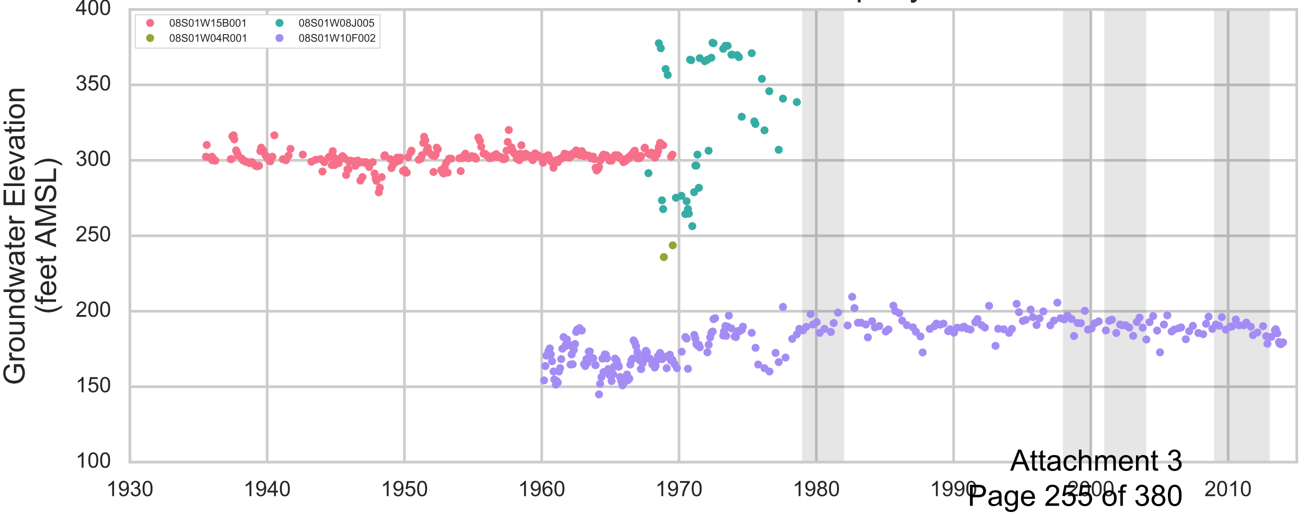
Groundwater Pumping in SJ Water Company Los Gatos: Local SW Area



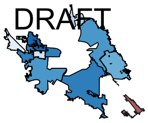
District Activity: Treated Water Delivery

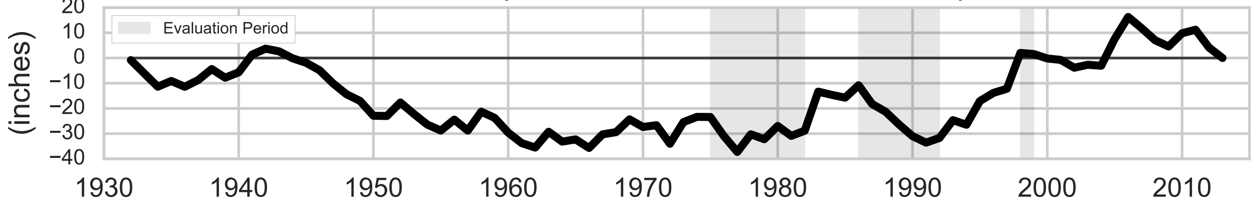


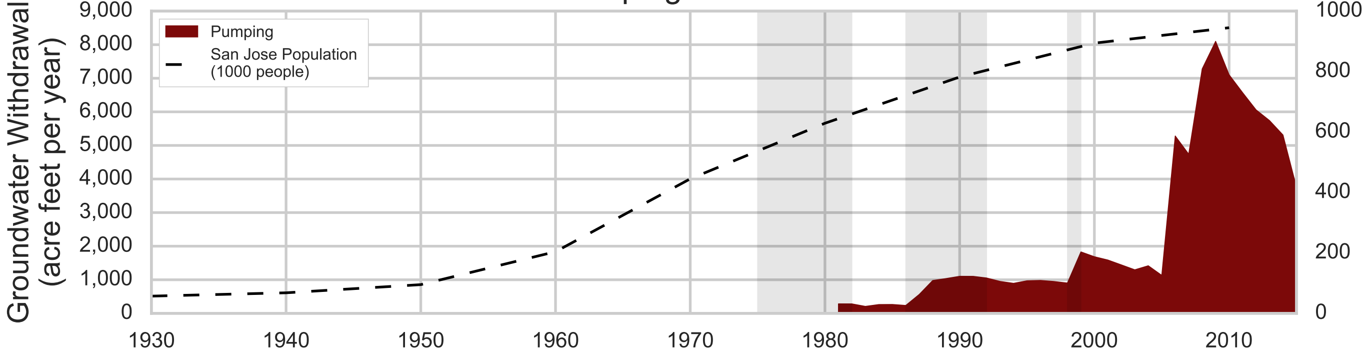
Observed Groundwater Elevations in SJ Water Company Los Gatos: Local SW Area

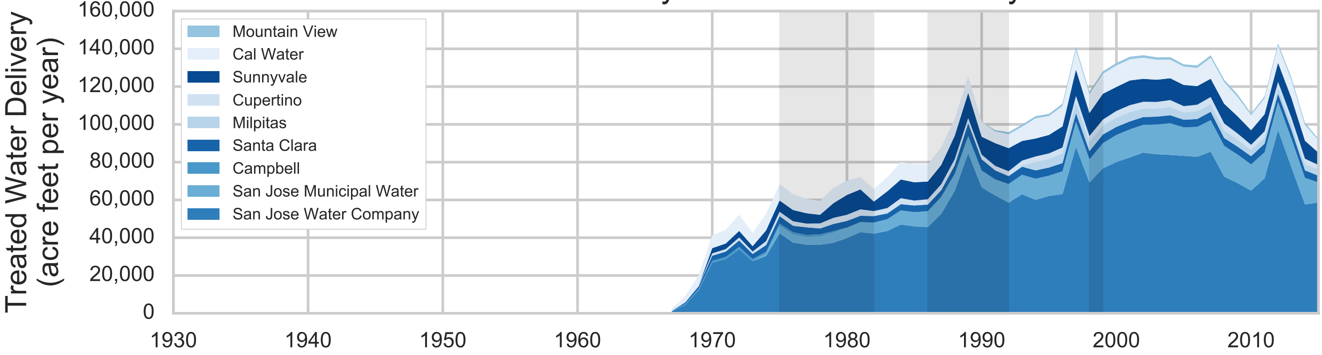


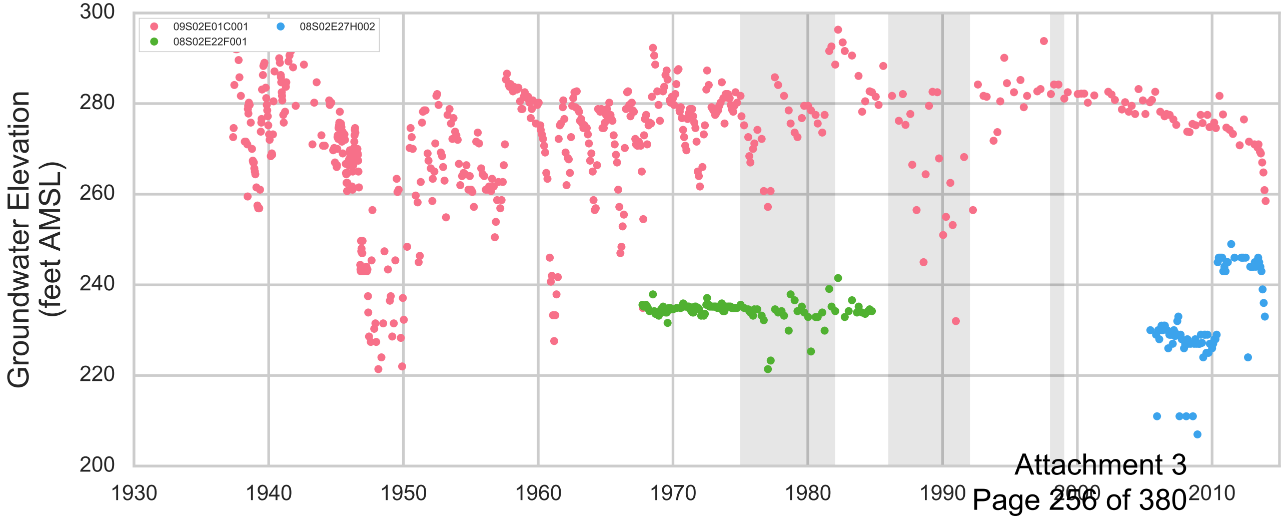
Pumping Area: San Jose Muni: GW
Activity: Treated Water Delivery
Groundwater Level Data from: Monitored Pumping Wells




Cumulative Departure from Mean Annual Precipitation

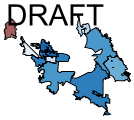

Groundwater Pumping in San Jose Muni: GW Area

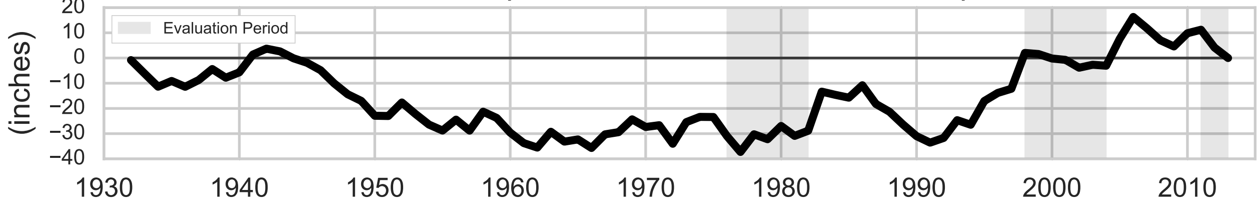

District Activity: Treated Water Delivery


Observed Groundwater Elevations in San Jose Muni: GW Area

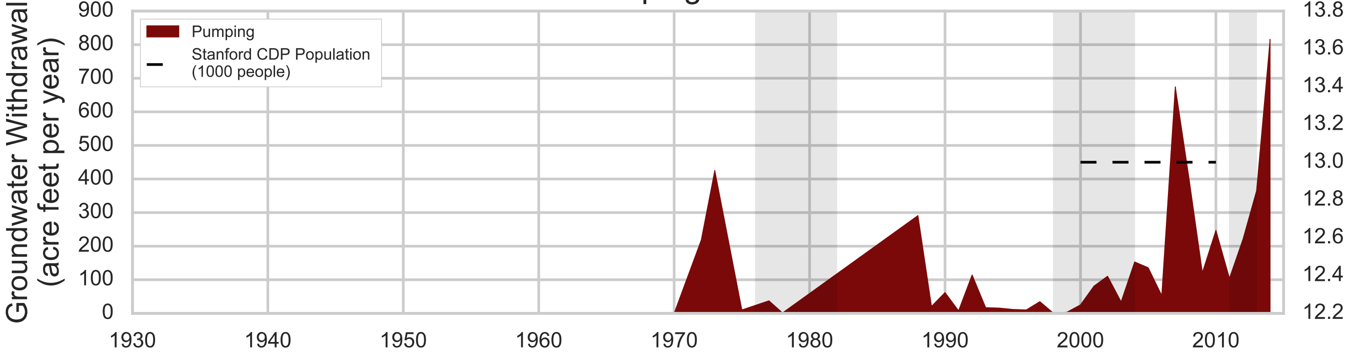
Pumping Area: Stanford: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitored Pumping Wells

DRAFT

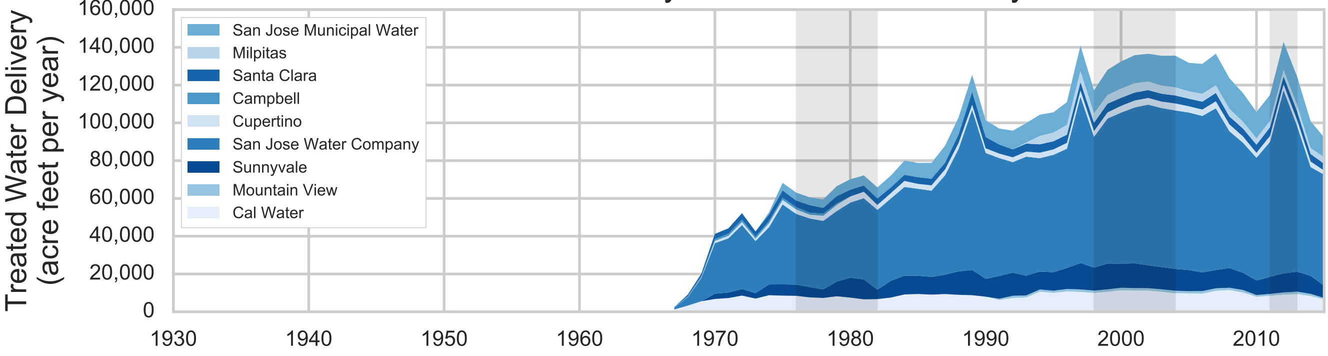




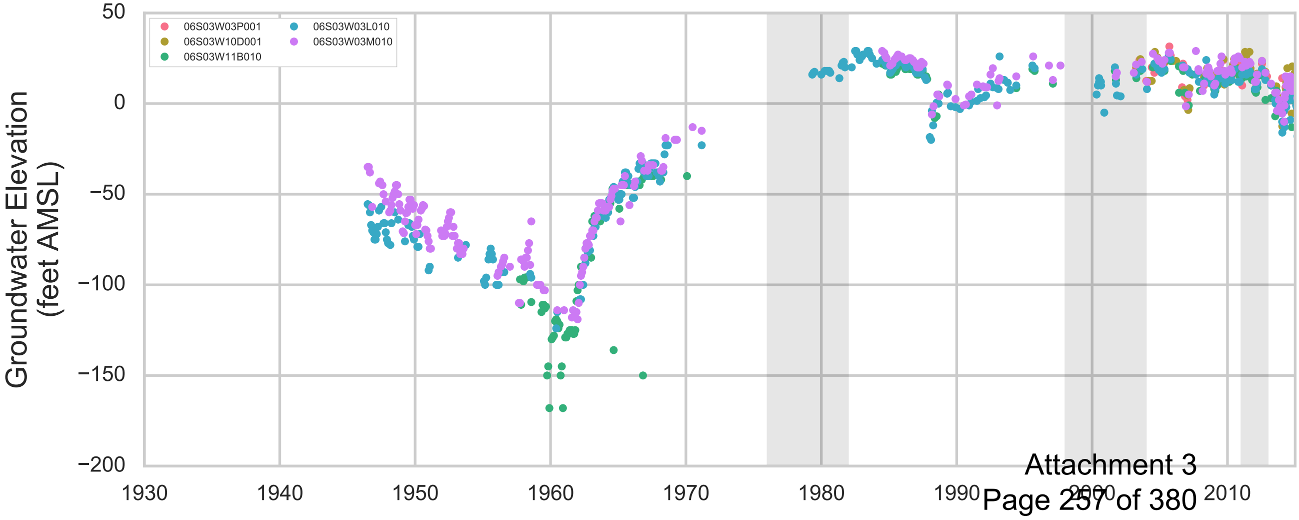
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in Stanford: RWS Area



District Activity: Treated Water Delivery



Observed Groundwater Elevations in Stanford: RWS Area

Pumping Area: Milpitas: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells

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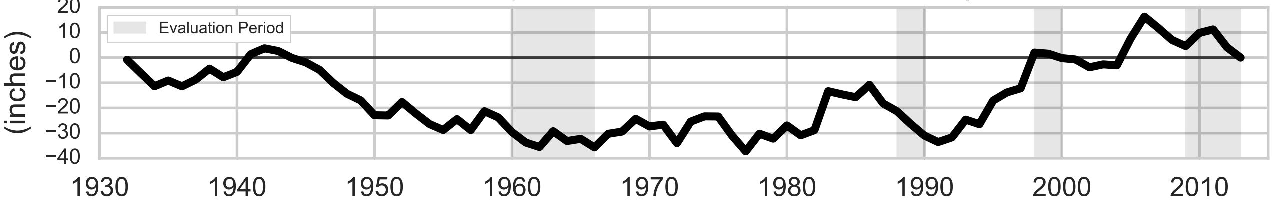
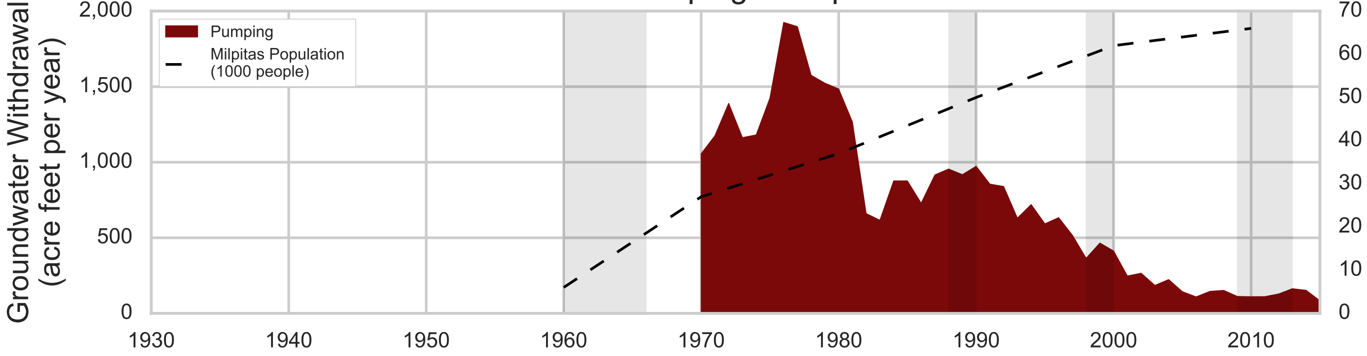
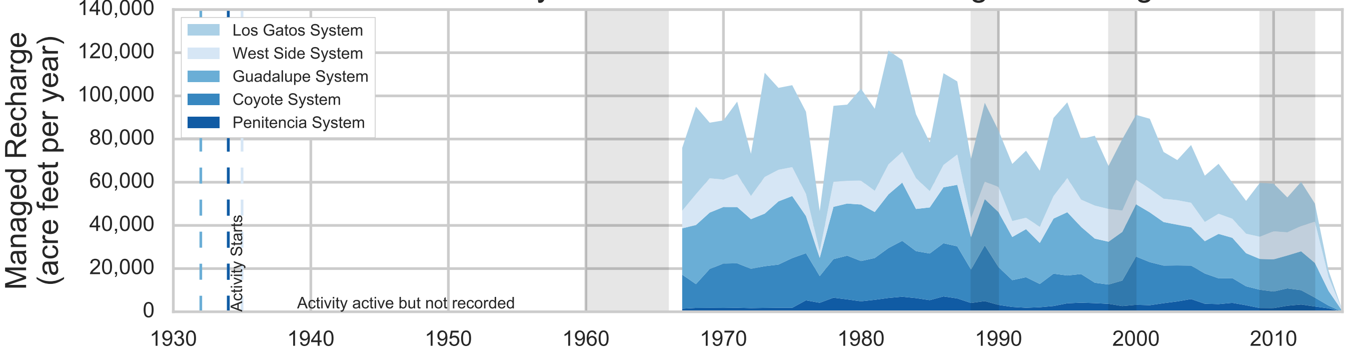
Cumulative Departure from Mean Annual Precipitation



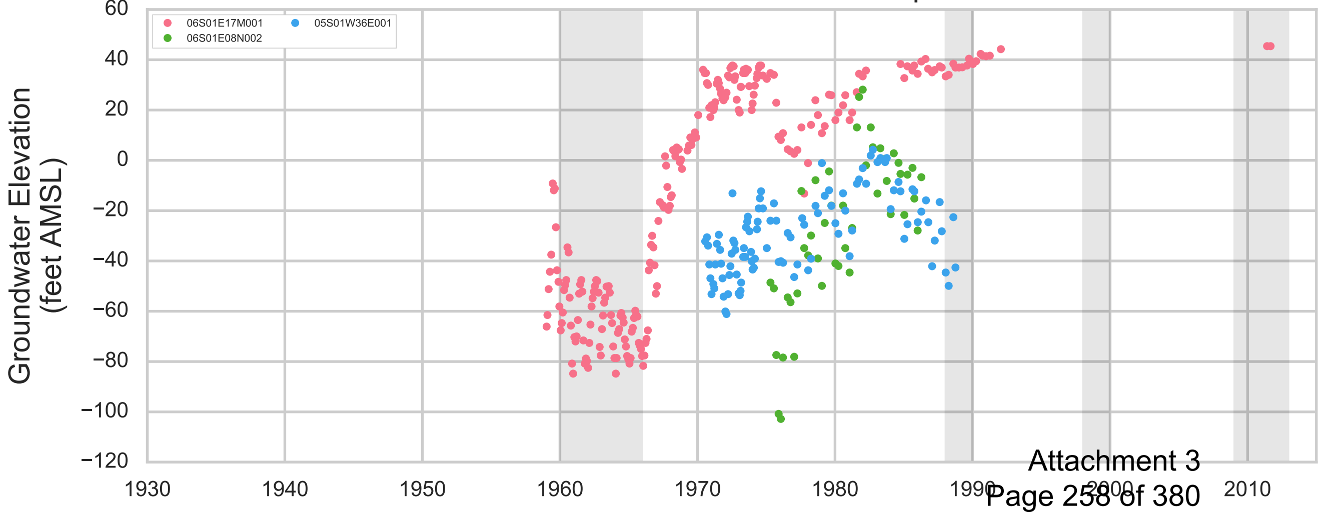
Groundwater Pumping in Milpitas: TW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in Milpitas: TW Area



Pumping Area: Palo Alto: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells

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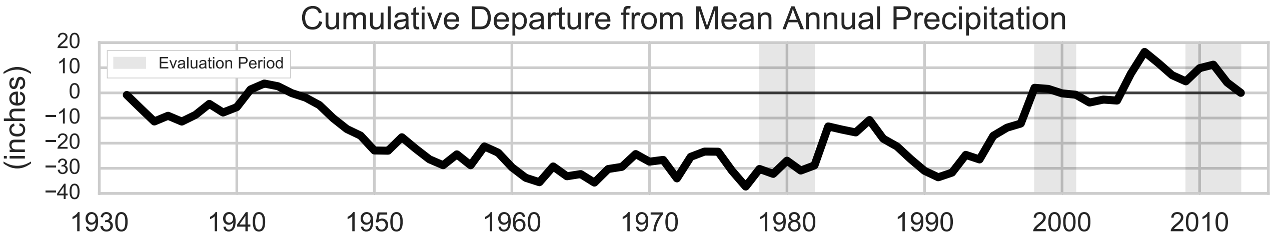
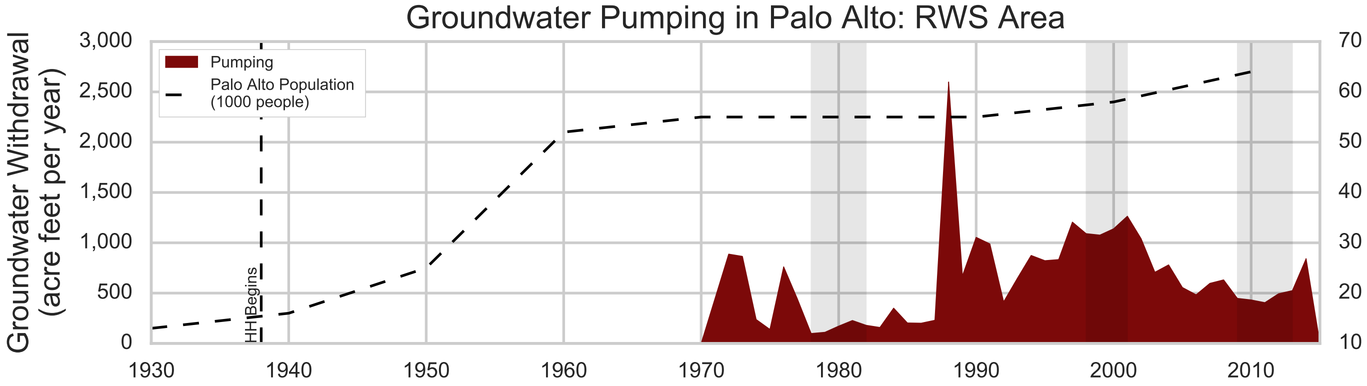
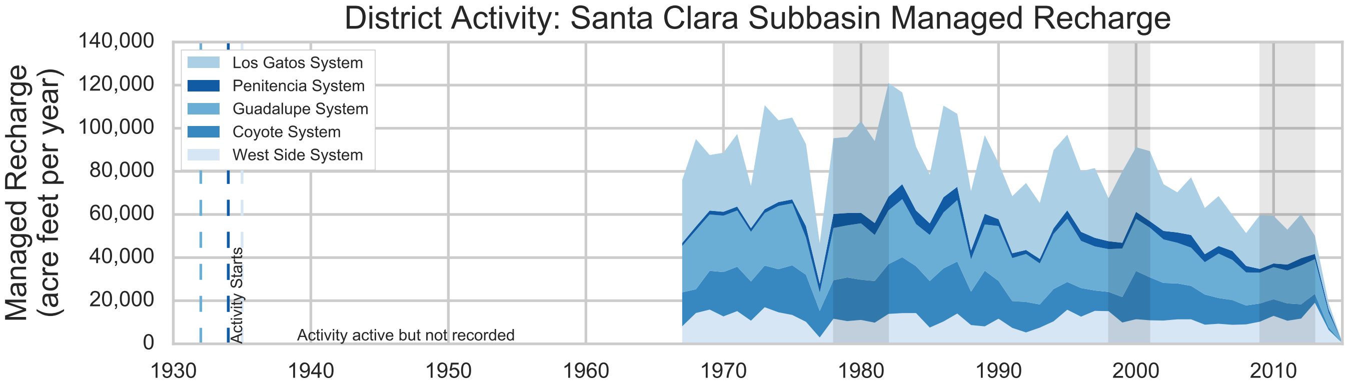
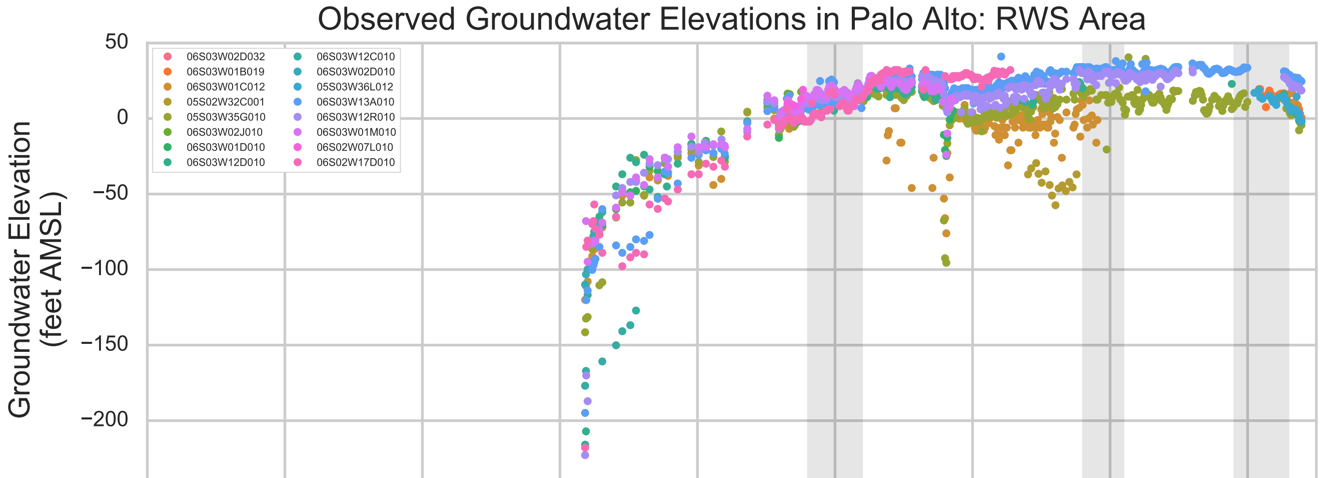

Cumulative Departure from Mean Annual Precipitation

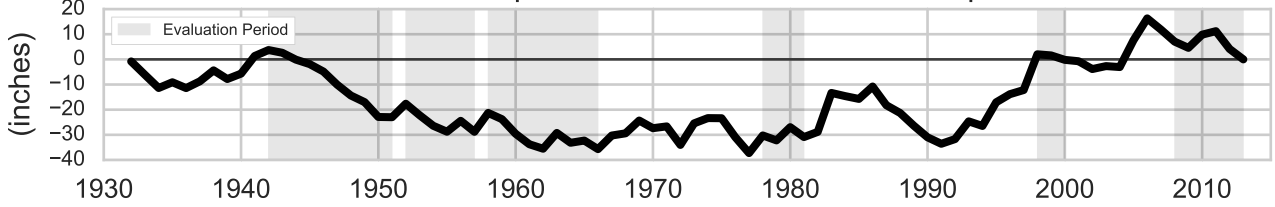

Groundwater Pumping in Palo Alto: RWS Area


District Activity: Santa Clara Subbasin Managed Recharge

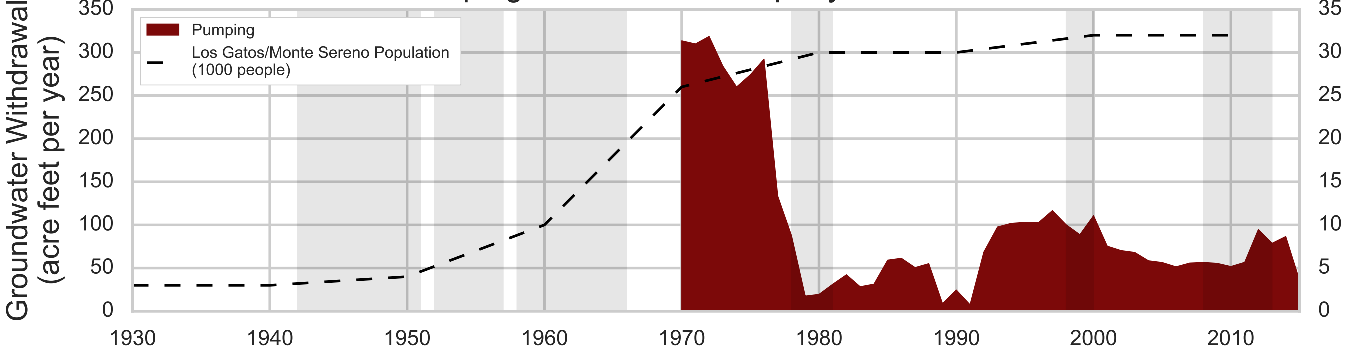

Observed Groundwater Elevations in Palo Alto: RWS Area

Pumping Area: SJ Water Company Los Gatos: Local SW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells

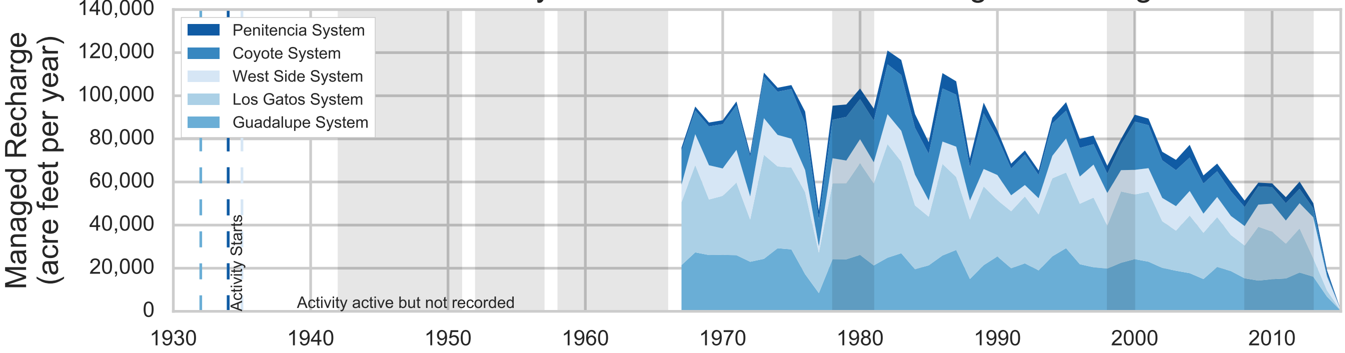
DRAFT



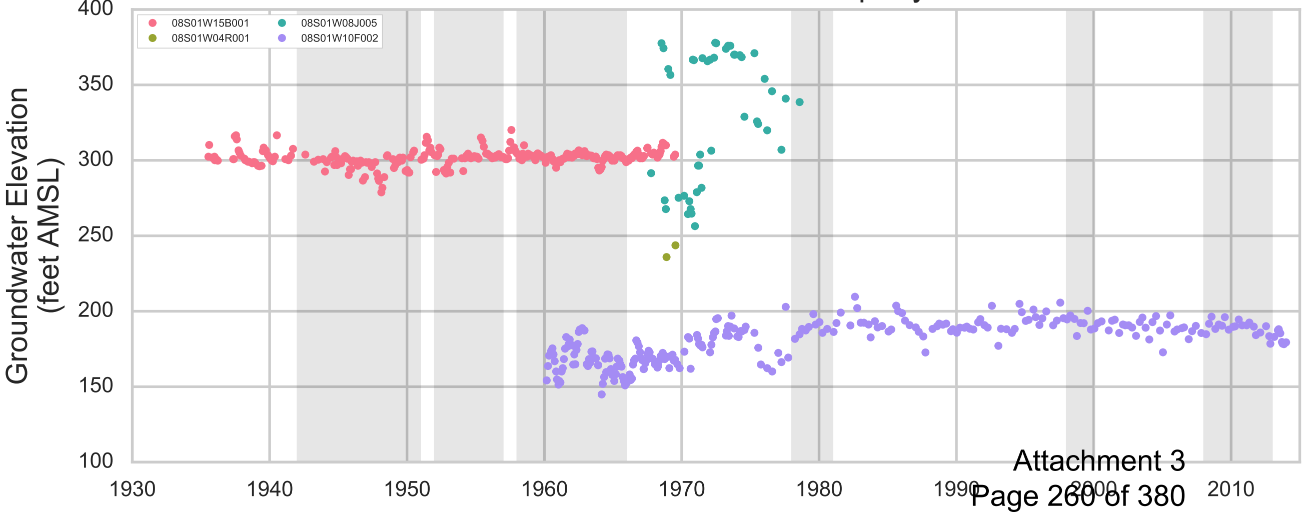
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in SJ Water Company Los Gatos: Local SW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in SJ Water Company Los Gatos: Local SW Area

Pumping Area: San Jose Muni: GW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells

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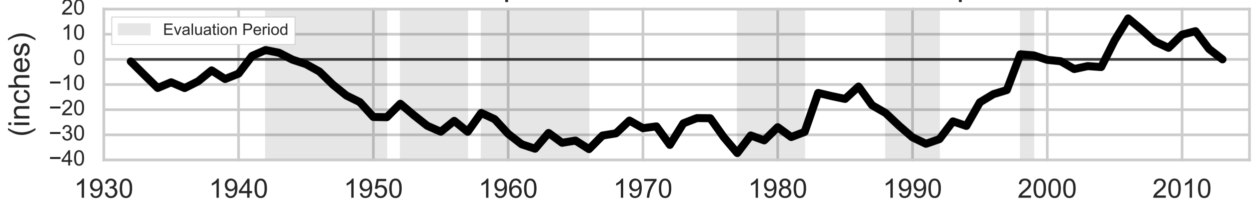
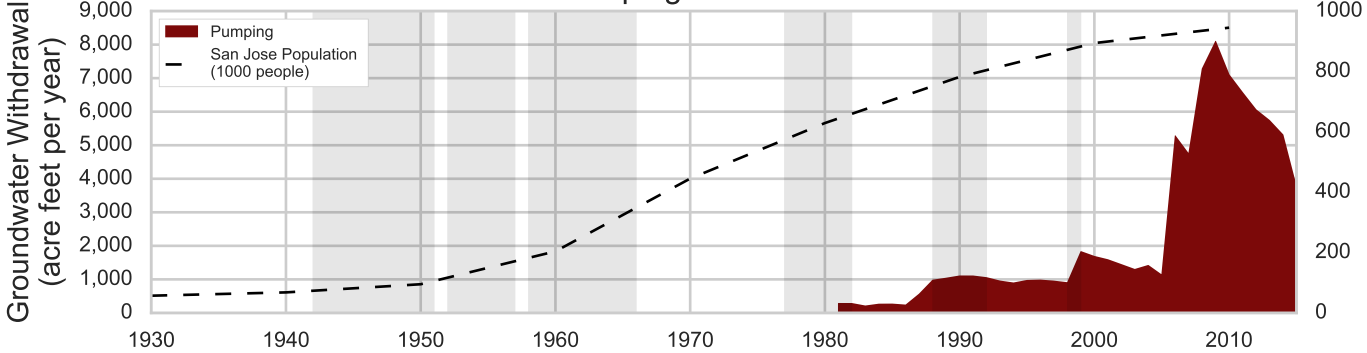
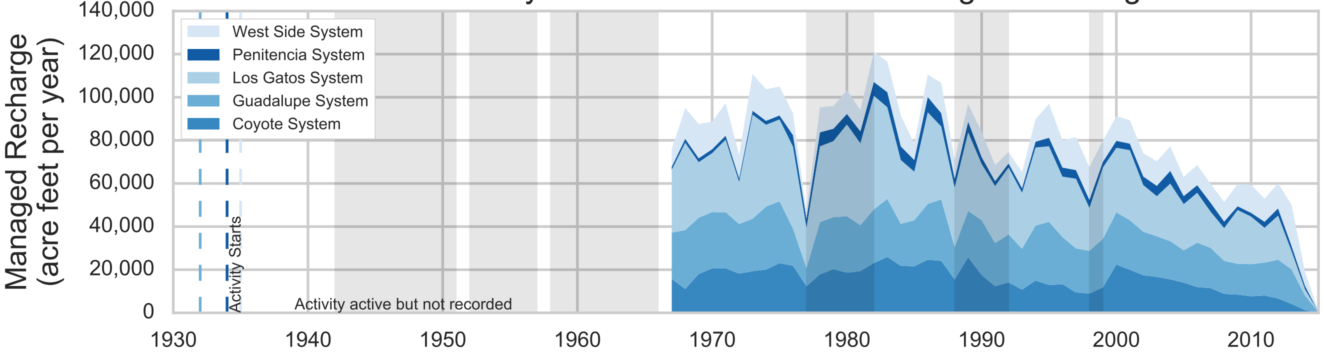
Cumulative Departure from Mean Annual Precipitation



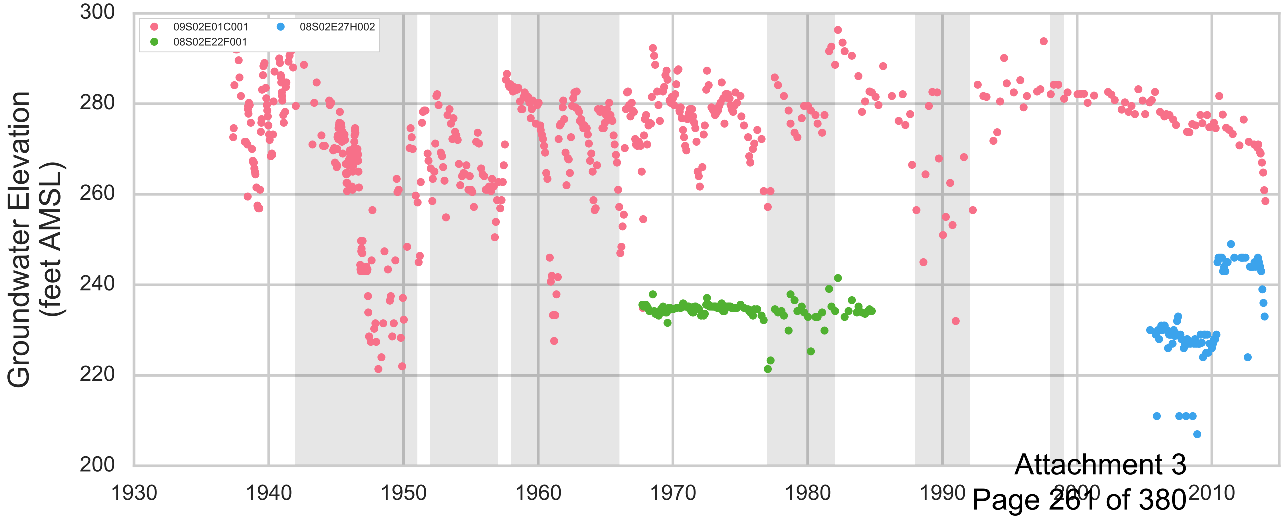
Groundwater Pumping in San Jose Muni: GW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in San Jose Muni: GW Area



Pumping Area: San Jose Muni: TW
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells

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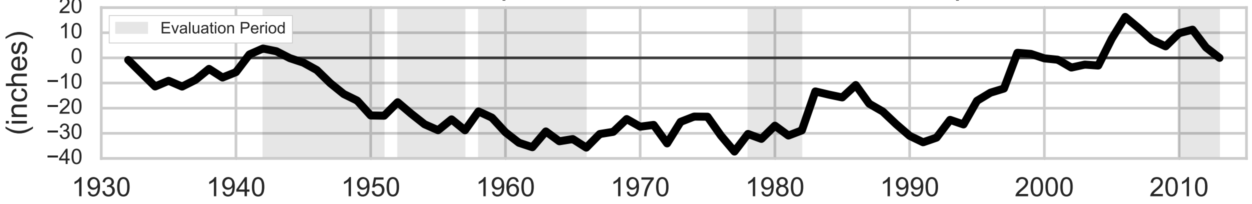
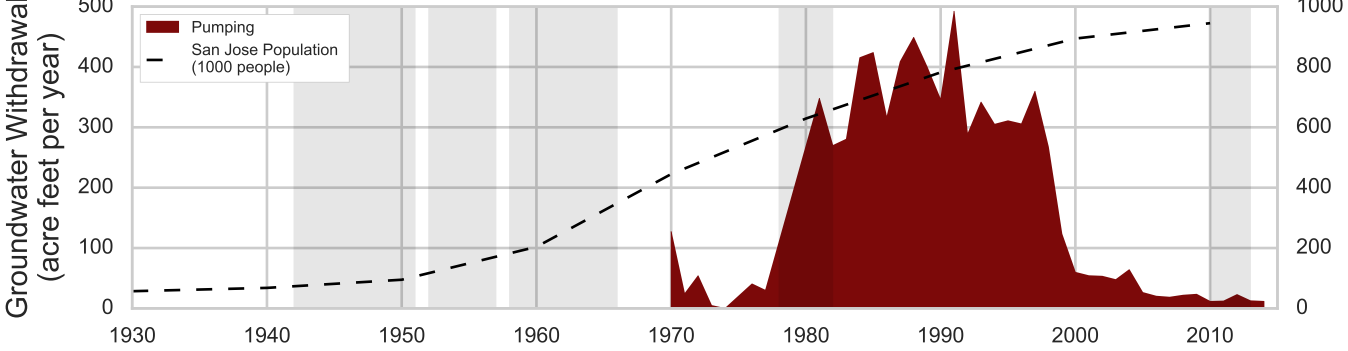
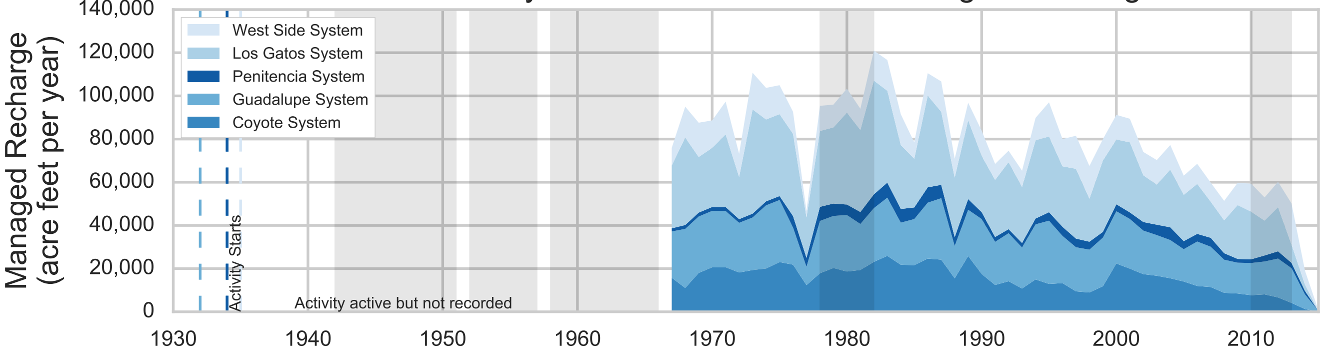


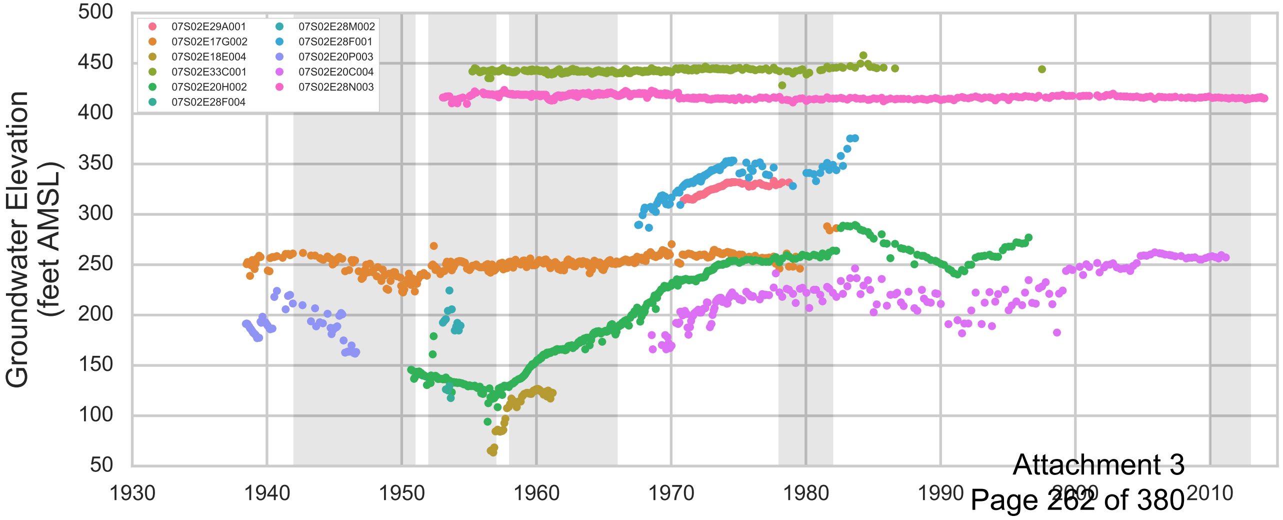
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in San Jose Muni: TW Area



District Activity: Santa Clara Subbasin Managed Recharge



Observed Groundwater Elevations in San Jose Muni: TW Area

Pumping Area: Stanford: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells

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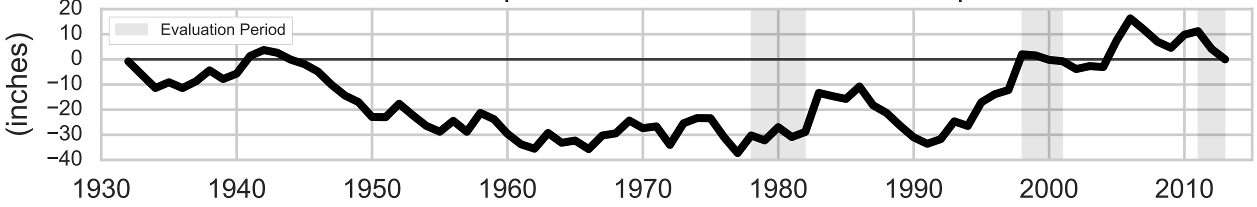
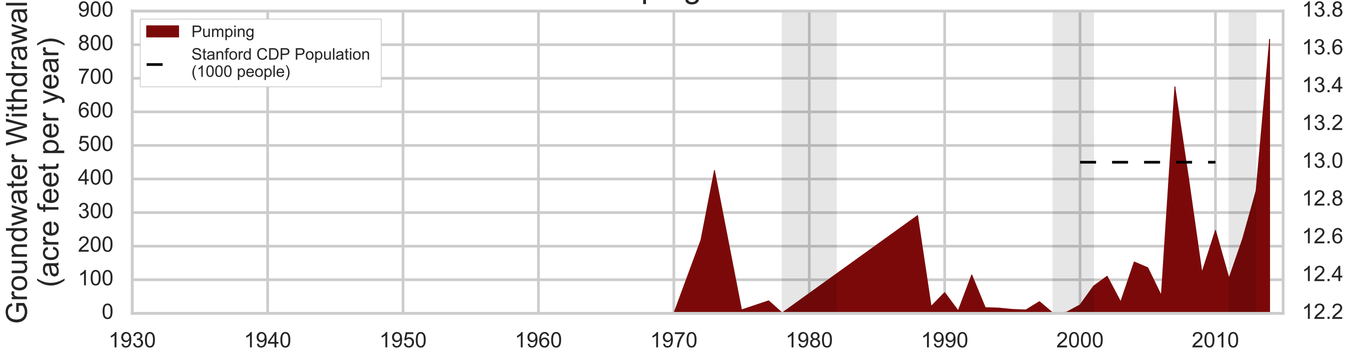
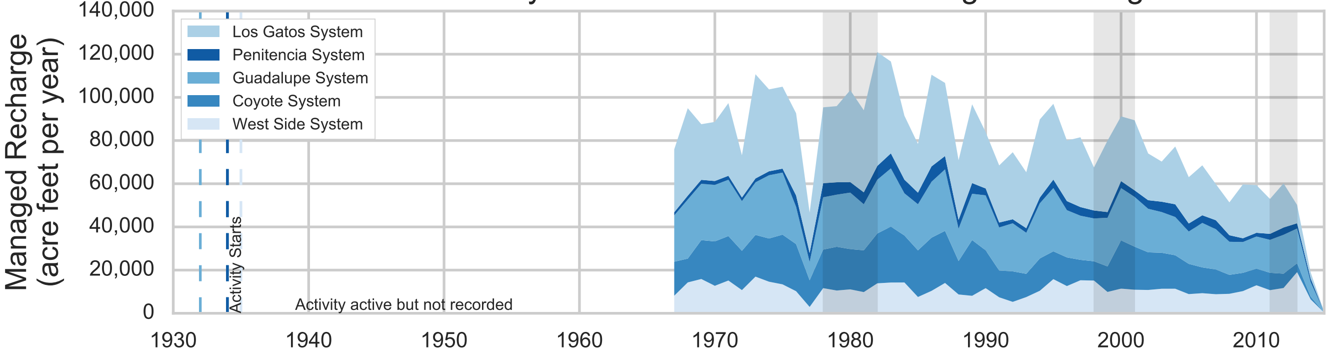
Cumulative Departure from Mean Annual Precipitation



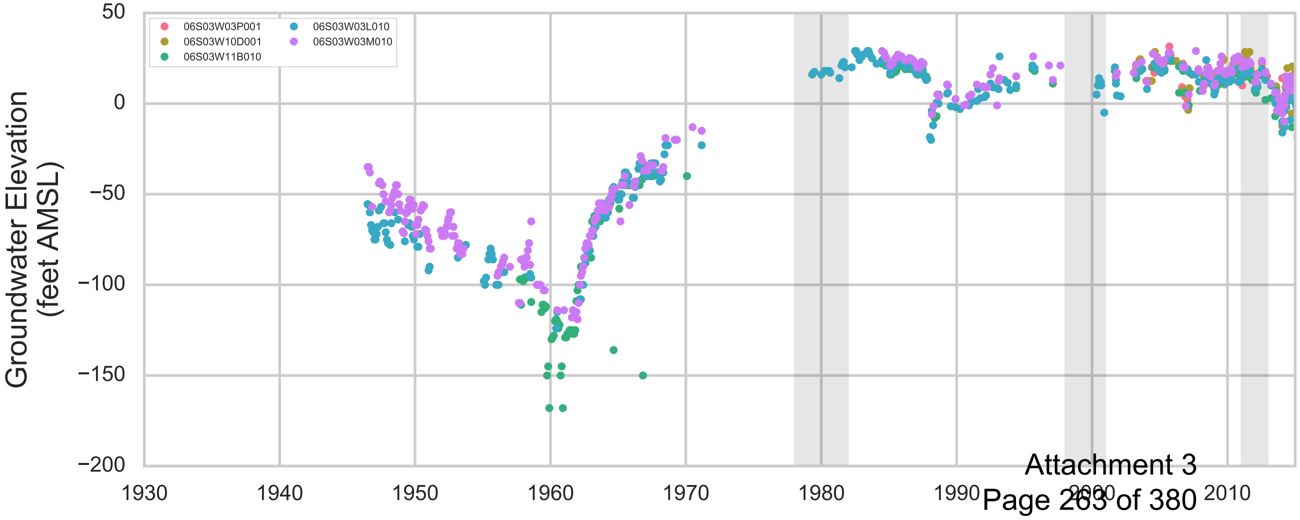
Groundwater Pumping in Stanford: RWS Area



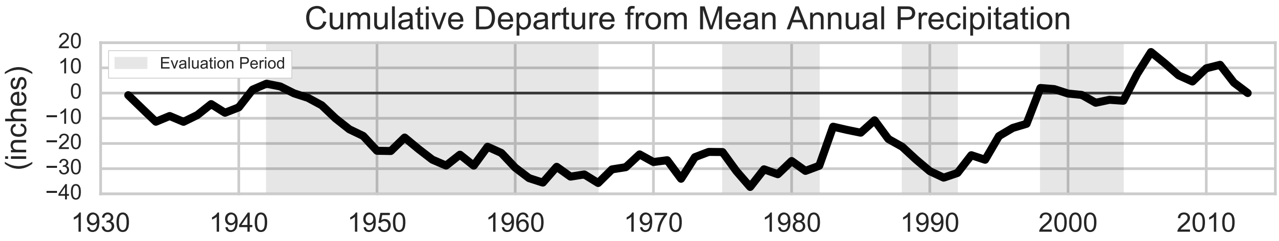
District Activity: Santa Clara Subbasin Managed Recharge

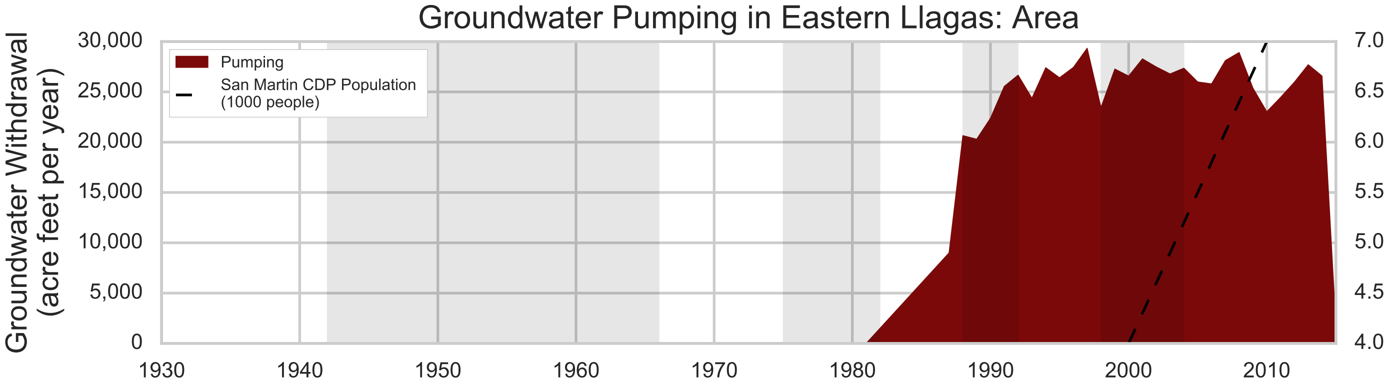


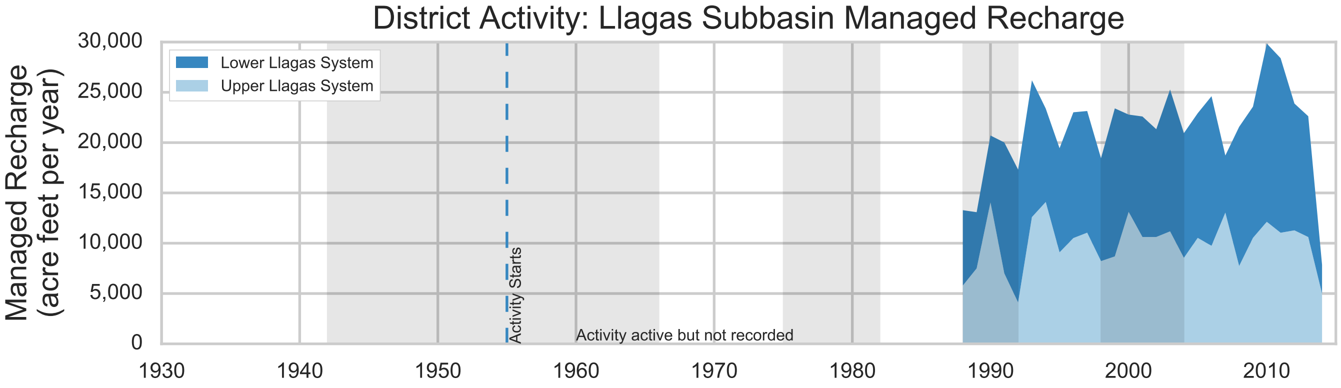
Observed Groundwater Elevations in Stanford: RWS Area

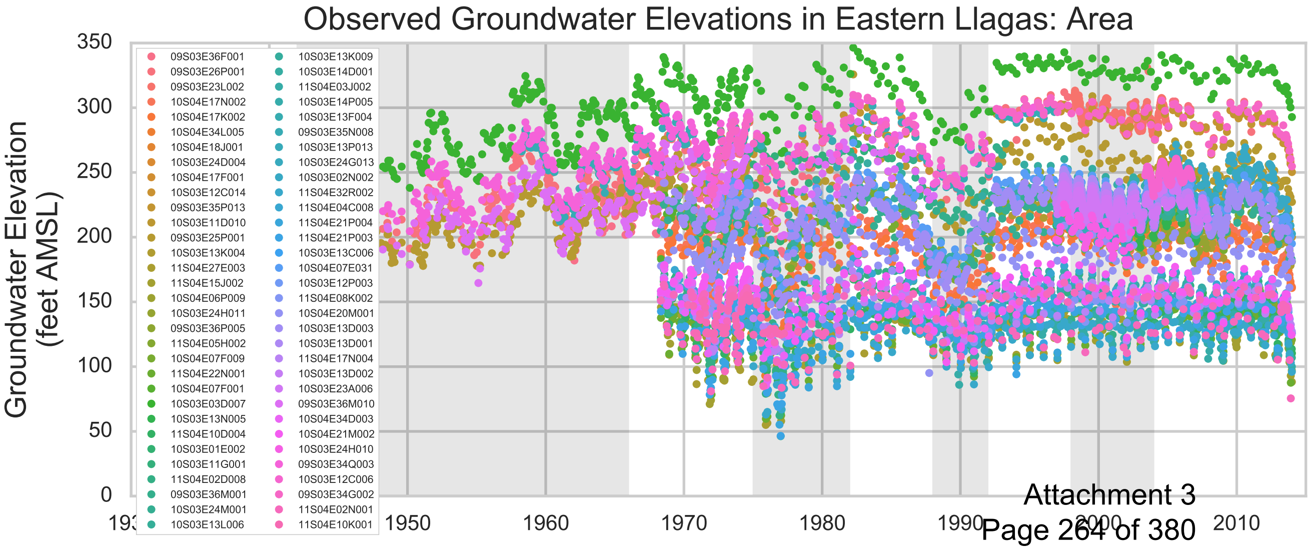


Pumping Area: Eastern Llagas:
Activity: Llagas Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells









Appendix G

Mann-Kendall Statistics for Groundwater Level Data

Activity	Pumping Area	Evaluation Period	Well Type	Visual Trend	Count of wells with n > 8	Average tau	Max tau	Min tau	Num tau >= 0	Average padj for tau >= 0	Num tau <0	Average padj for tau < 0
Santa Clara Subbasin Managed Recharge	Cal Water Cupertino: TW	2008-2013	Monitoring Wells	Decreasing	1	0.18	0.18	0.18	1	0.65	0	0.00
Santa Clara Subbasin Managed Recharge	Cal Water Los Altos: GW	1998-2001	Monitoring Wells	Stable	4	-0.10	0.40	-0.60	1	0.22	3	0.67
Santa Clara Subbasin Managed Recharge	Cal Water Los Altos: GW	2010-2013	Monitoring Wells	Decreasing	4	-0.01	0.08	-0.20	3	1.00	1	0.43
Santa Clara Subbasin Managed Recharge	Great Oaks: GW	2009-2013	Monitoring Wells	Decreasing	7	-0.79	-0.50	-1.00	0	0.00	7	0.39
Santa Clara Subbasin Managed Recharge	Milpitas: RWS	1988-1991	Monitoring Wells	Stable	1	1.00	1.00	1.00	1	0.30	0	0.00
Santa Clara Subbasin Managed Recharge	Milpitas: TW	2009-2013	Monitoring Wells	Stable	1	-0.28	-0.28	-0.28	0	0.00	1	0.54
Santa Clara Subbasin Managed Recharge	Morgan Hill: GW	1975-1982	Monitoring Wells	Increasing	4	-0.13	0.14	-0.40	2	0.53	2	0.58
Santa Clara Subbasin Managed Recharge	Morgan Hill: GW	1998-2001	Monitoring Wells	Decreasing	2	-0.18	-0.13	-0.23	0	0.00	2	0.51
Santa Clara Subbasin Managed Recharge	Morgan Hill: GW	2009-2013	Monitoring Wells	Decreasing	5	-0.33	-0.21	-0.43	0	0.00	5	0.40
Santa Clara Subbasin Managed Recharge	Mountain View: RWS	1988-1991	Monitoring Wells	Increasing	11	0.47	1.00	-0.33	10	0.33	1	0.46
Santa Clara Subbasin Managed Recharge	Mountain View: RWS	1998-2000	Monitoring Wells	Decreasing	1	-0.67	-0.67	-0.67	0	0.00	1	0.25
Santa Clara Subbasin Managed Recharge	Mountain View: RWS	2009-2013	Monitoring Wells	Decreasing	6	0.06	0.43	-0.38	4	0.64	2	0.63
Santa Clara Subbasin Managed Recharge	Mountain View: TW	2009-2013	Monitoring Wells	Decreasing	1	0.07	0.07	0.07	1	0.83	0	0.00
Santa Clara Subbasin Managed Recharge	North Morgan Hill:	2010-2013	Monitoring Wells	Decreasing	1	-0.73	-0.73	-0.73	0	0.00	1	0.20
Santa Clara Subbasin Managed Recharge	Palo Alto: RWS	1978-1982	Monitoring Wells	Stable	4	0.32	0.78	-0.19	3	0.20	1	0.71
Santa Clara Subbasin Managed Recharge	Palo Alto: RWS	1998-2001	Monitoring Wells	Stable	9	-0.37	0.17	-1.00	2	0.81	7	0.55
Santa Clara Subbasin Managed Recharge	Palo Alto: RWS	2009-2013	Monitoring Wells	Decreasing	11	-0.32	0.21	-1.00	3	0.86	8	0.42
Santa Clara Subbasin Managed Recharge	San Jose Muni: RWS	1988-1992	Monitoring Wells	Increasing	7	0.62	1.00	0.06	7	0.38	0	0.00
Santa Clara Subbasin Managed Recharge	San Jose Muni: RWS	2010-2012	Monitoring Wells	Increasing	6	0.94	1.00	0.67	6	0.37	0	0.00
Santa Clara Subbasin Managed Recharge	San Jose Muni: TW	1978-1982	Monitoring Wells	Increasing	7	0.59	1.00	-0.38	6	0.20	1	0.18
Santa Clara Subbasin Managed Recharge	San Jose Muni: TW	2010-2013	Monitoring Wells	Stable	7	0.00	1.00	-0.78	3	0.36	4	0.56
Santa Clara Subbasin Managed Recharge	Santa Clara: GW	1978-1981	Monitoring Wells	Stable	4	-0.35	0.33	-1.00	1	0.37	3	0.33
Santa Clara Subbasin Managed Recharge	Santa Clara: GW	1999-2001	Monitoring Wells	Lacks Data	1	0.00	0.00	0.00	1	1.00	0	0.00
Santa Clara Subbasin Managed Recharge	Santa Clara: GW	2009-2013	Monitoring Wells	Decreasing	1	0.33	0.33	0.33	1	0.54	0	0.00
Santa Clara Subbasin Managed Recharge	Santa Clara: RWS	2008-2010	Monitoring Wells	Stable	1	0.00	0.00	0.00	1	1.00	0	0.00
Santa Clara Subbasin Managed Recharge	Santa Clara: RWS	2011-2013	Monitoring Wells	Stable	1	0.00	0.00	0.00	1	1.00	0	0.00
Santa Clara Subbasin Managed Recharge	Santa Clara: RWS GW	1978-1981	Monitoring Wells	Increasing	3	0.53	0.67	0.43	3	0.26	0	0.00
Santa Clara Subbasin Managed Recharge	Santa Clara: RWS GW	2011-2013	Monitoring Wells	Stable	2	-0.75	-0.67	-0.83	0	0.00	2	0.39
Santa Clara Subbasin Managed Recharge	Santa Clara: TW GW	1977-1980	Monitoring Wells	Decreasing	1	0.11	0.11	0.11	1	1.00	0	0.00
Santa Clara Subbasin Managed Recharge	Santa Clara: TW GW	2010-2012	Monitoring Wells	Increasing	4	1.00	1.00	1.00	4	0.30	0	0.00
Santa Clara Subbasin Managed Recharge	SJ Water Company East: TW	1978-1981	Monitoring Wells	Increasing	11	0.41	1.00	-0.58	10	0.44	1	0.22
Santa Clara Subbasin Managed Recharge	SJ Water Company East: TW	1998-2001	Monitoring Wells	Stable	6	-0.38	0.20	-0.90	1	0.85	5	0.41
Santa Clara Subbasin Managed Recharge	SJ Water Company East: TW	2009-2013	Monitoring Wells	Stable	6	0.15	0.47	-0.33	4	0.39	2	0.57
Santa Clara Subbasin Managed Recharge	SJ Water Company Los Gatos: Local SW	1978-1981	Monitoring Wells	Stable	1	-0.33	-0.33	-0.33	0	0.00	1	0.60
Santa Clara Subbasin Managed Recharge	SJ Water Company North: GW	1978-1981	Monitoring Wells	Increasing	17	0.22	1.00	-0.40	12	0.45	5	0.55
Santa Clara Subbasin Managed Recharge	SJ Water Company North: GW	2011-2013	Monitoring Wells	Decreasing	21	-0.64	0.50	-1.00	3	0.77	18	0.53
Santa Clara Subbasin Managed Recharge	SJ Water Company South: TW	1998-2001	Monitoring Wells	Decreasing	8	-0.57	-0.20	-0.89	0	0.00	8	0.35
Santa Clara Subbasin Managed Recharge	SJ Water Company South: TW	2008-2013	Monitoring Wells	Stable	10	0.23	0.57	-0.52	7	0.25	3	0.32
Santa Clara Subbasin Managed Recharge	SJ Water Company West: TW	1988-1992	Monitoring Wells	Stable	5	0.31	0.83	-0.33	3	0.05	2	0.68
Santa Clara Subbasin Managed Recharge	SJ Water Company West: TW	2009-2012	Monitoring Wells	Increasing	5	0.86	1.00	0.71	5	0.12	0	0.00
Santa Clara Subbasin Managed Recharge	Sunnyvale: RWS	1977-1979	Monitoring Wells	Stable	4	0.33	1.00	-0.33	2	0.37	2	1.00
Santa Clara Subbasin Managed Recharge	Sunnyvale: RWS	1988-1992	Monitoring Wells	Increasing	3	0.94	1.00	0.91	3	0.06	0	0.00
Santa Clara Subbasin Managed Recharge	Sunnyvale: RWS	2010-2012	Monitoring Wells	Stable	2	0.33	1.00	-0.33	0	0.00	1	0.82
Santa Clara Subbasin Managed Recharge	Sunnyvale: TW	1980-1982	Monitoring Wells	Stable	1	-0.33	-0.33	-0.33	0	0.00	1	1.00

Activity	Pumping Area	Evaluation Period	Well Type	Visual Trend	Count of wells with n > 8	Average tau	Max tau	Min tau	Num tau >= 0	Average padj for tau >= 0	Num tau <0	Average padj for tau < 0
Treated Water Delivery	Cal Water Los Altos: GW	1986-1988	Monitoring Wells	Stable	7	-0.52	0.00	-1.00	1	1.00	6	0.62
Treated Water Delivery	Cal Water Los Altos: GW	1998-2004	Monitoring Wells	Stable	14	-0.17	0.50	-0.62	3	0.69	11	0.38
Treated Water Delivery	Cal Water Los Altos: GW	2010-2013	Monitoring Wells	Decreasing	12	-0.10	0.20	-0.42	6	1.00	6	0.56
Treated Water Delivery	Cal Water Mountain View: GW	1980-1982	Monitoring Wells	Increasing	3	0.33	0.33	0.33	3	1.00	0	0.00
Treated Water Delivery	Cal Water Mountain View: GW	1986-1992	Monitoring Wells	Increasing	3	0.41	0.60	0.30	3	0.19	0	0.00
Treated Water Delivery	Cal Water Mountain View: GW	1998-2004	Monitoring Wells	Decreasing	3	-0.21	0.39	-0.62	1	0.53	2	0.14
Treated Water Delivery	Cal Water Mountain View: GW	2010-2013	Monitoring Wells	Stable	1	-0.08	-0.08	-0.08	0	0.00	1	1.00
Treated Water Delivery	Cal Water Sunnyvale: GW	1998-2004	Monitoring Wells	Decreasing	5	-0.36	-0.02	-0.79	0	0.00	5	0.29
Treated Water Delivery	Cal Water Sunnyvale: GW	2009-2013	Monitoring Wells	Stable	5	0.27	0.58	-0.14	4	0.20	1	0.66
Treated Water Delivery	Great Oaks: GW	1975-1982	Monitoring Wells	Stable	9	-0.37	0.21	-1.00	1	0.26	8	0.38
Treated Water Delivery	Great Oaks: GW	1998-2004	Monitoring Wells	Decreasing	4	-0.14	0.00	-0.24	1	1.00	3	0.67
Treated Water Delivery	Great Oaks: GW	2009-2013	Monitoring Wells	Decreasing	8	-0.77	-0.50	-1.00	0	0.00	8	0.36
Treated Water Delivery	Milpitas: RWS	1975-1982	Monitoring Wells	Increasing	4	-0.19	0.64	-1.00	2	0.26	2	0.25
Treated Water Delivery	Milpitas: RWS	1986-1991	Monitoring Wells	Lacks Data	1	-0.28	-0.28	-0.28	0	0.00	1	0.46
Treated Water Delivery	Morgan Hill: GW	1975-1982	Monitoring Wells	Increasing	5	0.03	0.24	-0.40	3	0.44	2	0.77
Treated Water Delivery	Morgan Hill: GW	1986-1992	Monitoring Wells	Decreasing	4	-0.29	-0.16	-0.40	0	0.00	4	0.24
Treated Water Delivery	Morgan Hill: GW	1998-2004	Monitoring Wells	Decreasing	3	-0.19	0.13	-0.48	1	0.58	2	0.17
Treated Water Delivery	Morgan Hill: GW	2009-2013	Monitoring Wells	Decreasing	7	-0.31	0.00	-0.56	1	1.00	6	0.37
Treated Water Delivery	Mountain View: RWS	1986-1991	Monitoring Wells	Increasing	11	0.01	0.60	-0.53	5	0.46	6	0.55
Treated Water Delivery	Mountain View: RWS	1998-2000	Monitoring Wells	Decreasing	2	-0.83	-0.67	-1.00	0	0.00	2	0.27
Treated Water Delivery	Mountain View: RWS	2001-2004	Monitoring Wells	Stable	4	0.43	1.00	-0.50	3	0.64	1	0.72
Treated Water Delivery	Mountain View: RWS	2009-2013	Monitoring Wells	Decreasing	7	0.04	0.43	-0.38	4	0.64	3	0.75
Treated Water Delivery	North Morgan Hill:	1986-1992	Monitoring Wells	Decreasing	2	-0.31	-0.11	-0.50	0	0.00	2	0.27
Treated Water Delivery	North Morgan Hill:	1999-2004	Monitoring Wells	Decreasing	2	-0.47	-0.31	-0.64	0	0.00	2	0.16
Treated Water Delivery	North Morgan Hill:	2010-2013	Monitoring Wells	Decreasing	3	-0.78	-0.73	-0.87	0	0.00	3	0.18
Treated Water Delivery	Palo Alto: RWS	1975-1982	Monitoring Wells	Stable	5	0.47	0.78	0.16	5	0.19	0	0.00
Treated Water Delivery	Palo Alto: RWS	1986-1992	Monitoring Wells	Decreasing	5	-0.46	-0.13	-0.80	0	0.00	5	0.22
Treated Water Delivery	Palo Alto: RWS	1998-2002	Monitoring Wells	Stable	9	-0.55	-0.28	-0.87	0	0.00	9	0.24
Treated Water Delivery	Palo Alto: RWS	2009-2013	Monitoring Wells	Decreasing	11	-0.32	0.21	-1.00	3	0.86	8	0.42
Treated Water Delivery	San Jose Muni: RWS	1986-1992	Monitoring Wells	Increasing	10	0.36	0.75	-0.33	8	0.22	2	0.41
Treated Water Delivery	San Jose Muni: RWS	2000-2003	Monitoring Wells	Lacks Data	3	0.50	1.00	0.00	3	0.48	0	0.00
Treated Water Delivery	San Jose Muni: RWS	2010-2012	Monitoring Wells	Increasing	7	0.90	1.00	0.67	7	0.35	0	0.00
Treated Water Delivery	Santa Clara: GW	1975-1982	Monitoring Wells	Stable	11	-0.12	0.21	-0.80	7	0.64	4	0.12
Treated Water Delivery	Santa Clara: GW	1999-2001	Monitoring Wells	Lacks Data	1	0.00	0.00	0.00	1	1.00	0	0.00
Treated Water Delivery	Santa Clara: GW	2009-2013	Monitoring Wells	Lacks Data	1	0.33	0.33	0.33	1	0.54	0	0.00
Treated Water Delivery	Santa Clara: RWS	2011-2013	Monitoring Wells	Lacks Data	1	0.00	0.00	0.00	1	1.00	0	0.00
Treated Water Delivery	Santa Clara: RWS GW	1975-1981	Monitoring Wells	Increasing	6	-0.13	0.31	-0.50	3	0.55	3	0.54
Treated Water Delivery	Santa Clara: RWS GW	2011-2013	Monitoring Wells	Stable	2	-0.75	-0.67	-0.83	0	0.00	2	0.39
Treated Water Delivery	SJ Water Company Los Gatos: Local SW	1979-1982	Monitoring Wells	Stable	2	-0.02	0.11	-0.14	1	1.00	1	1.00
Treated Water Delivery	SJ Water Company Los Gatos: Local SW	1998-2000	Monitoring Wells	Decreasing	1	-1.00	-1.00	-1.00	0	0.00	1	0.30
Treated Water Delivery	SJ Water Company Los Gatos: Local SW	2001-2004	Monitoring Wells	Decreasing	1	-0.13	-0.13	-0.13	0	0.00	1	1.00
Treated Water Delivery	SJ Water Company Los Gatos: Local SW	2009-2013	Monitoring Wells	Decreasing	1	-0.53	-0.53	-0.53	0	0.00	1	0.22
Treated Water Delivery	SJ Water Company North: GW	1975-1982	Monitoring Wells	Increasing	31	0.04	0.46	-0.83	20	0.48	11	0.45
Treated Water Delivery	SJ Water Company North: GW	2011-2013	Monitoring Wells	Decreasing	23	-0.65	0.50	-1.00	3	0.77	20	0.53
Treated Water Delivery	Sunnyvale: RWS	1987-1992	Monitoring Wells	Increasing	3	0.85	0.89	0.78	0	0.00	0	0.00
Treated Water Delivery	Sunnyvale: RWS	2010-2012	Monitoring Wells	Increasing	2	0.33	1.00	-0.33	0	0.00	1	0.82
Llagas Subbasin Managed Recharge	Eastern Llagas:	1975-1982	Monitoring Wells	Increasing	3	0.45	0.54	0.34	3	0.09	0	0.00
Llagas Subbasin Managed Recharge	Eastern Llagas:	1988-1992	Monitoring Wells	Decreasing	3	0.13	0.56	-0.50	2	0.35	1	0.58
Llagas Subbasin Managed Recharge	Eastern Llagas:	1998-2004	Monitoring Wells	Stable	28	-0.15	0.33	-0.74	10	0.99	18	0.38
Llagas Subbasin Managed Recharge	Gilroy: GW	1975-1982	Monitoring Wells	Increasing	3	0.05	0.45	-0.50	2	0.32	1	0.43
Llagas Subbasin Managed Recharge	Gilroy: GW	1998-2004	Monitoring Wells	Decreasing	1	-0.50	-0.50	-0.50	0	0.00	1	0.06
Llagas Subbasin Managed Recharge	Gilroy: GW	2006-2010	Monitoring Wells	Stable	3	-0.02	0.29	-0.21	1	0.40	2	0.71
Llagas Subbasin Managed Recharge	Morgan Hill: GW	1975-1982	Monitoring Wells	Increasing	2	-0.13	0.14	-0.40	1	0.53	1	0.58
Llagas Subbasin Managed Recharge	Morgan Hill: GW	1998-2004	Monitoring Wells	Decreasing	1	-0.23	-0.23	-0.23	0	0.00	1	0.24

Activity	Pumping Area	Evaluation Period	Well Type	Visual Trend	Count of wells with n > 8	Average tau	Max tau	Min tau	Num tau >= 0	Average padj for tau >= 0	Num tau <0	Average padj for tau < 0
Santa Clara Subbasin Managed Recharge	Great Oaks: GW	1998-2001	Monitored Pumping Wells	Decreasing	16	-0.20	0.60	-1.00	7	0.65	9	0.37
Santa Clara Subbasin Managed Recharge	Milpitas: RWS	1988-1991	Monitored Pumping Wells	Increasing	1	0.83	0.83	0.83	1	0.10	0	0.00
Santa Clara Subbasin Managed Recharge	Morgan Hill: GW	1975-1982	Monitored Pumping Wells	Increasing	2	0.35	0.35	0.35	2	0.12	0	0.00
Santa Clara Subbasin Managed Recharge	Morgan Hill: GW	1998-2001	Monitored Pumping Wells	Decreasing	21	-0.07	0.67	-0.55	9	0.78	12	0.49
Santa Clara Subbasin Managed Recharge	Mountain View: RWS	1998-2000	Monitored Pumping Wells	Decreasing	3	-0.61	-0.33	-1.00	0	0.00	3	0.72
Santa Clara Subbasin Managed Recharge	Mountain View: TW	1998-2001	Monitored Pumping Wells	Decreasing	2	-0.57	-0.40	-0.73	0	0.00	0	0.35
Santa Clara Subbasin Managed Recharge	North Morgan Hill:	1978-1982	Monitored Pumping Wells	Increasing	2	-0.27	-0.11	-0.43	0	0.00	2	0.44
Santa Clara Subbasin Managed Recharge	North Morgan Hill:	1999-2001	Monitored Pumping Wells	Decreasing	5	0.07	0.33	-0.33	4	1.00	1	1.00
Santa Clara Subbasin Managed Recharge	Palo Alto: RWS	1978-1982	Monitored Pumping Wells	Increasing	8	0.62	0.76	0.40	8	0.10	0	0.00
Santa Clara Subbasin Managed Recharge	Palo Alto: RWS	1998-2001	Monitored Pumping Wells	Stable	4	-0.46	-0.17	-1.00	0	0.00	4	0.68
Santa Clara Subbasin Managed Recharge	Palo Alto: RWS	2009-2013	Monitored Pumping Wells	Decreasing	4	-0.96	-0.86	-1.00	0	0.00	4	0.40
Santa Clara Subbasin Managed Recharge	San Jose Muni: GW	1977-1982	Monitored Pumping Wells	Increasing	1	0.12	0.12	0.12	1	0.70	0	0.00
Santa Clara Subbasin Managed Recharge	San Jose Muni: TW	1978-1982	Monitored Pumping Wells	Stable	2	0.33	0.83	-0.17	1	0.20	1	0.72
Santa Clara Subbasin Managed Recharge	Santa Clara: GW	1978-1981	Monitored Pumping Wells	Stable	9	0.37	0.71	-0.11	8	0.55	1	1.00
Santa Clara Subbasin Managed Recharge	Santa Clara: GW	1999-2001	Monitored Pumping Wells	Decreasing	13	-0.33	0.67	-1.00	4	0.74	9	0.50
Santa Clara Subbasin Managed Recharge	Santa Clara: RWS GW	1978-1981	Monitored Pumping Wells	Stable	2	0.55	0.60	0.50	2	0.46	0	0.00
Santa Clara Subbasin Managed Recharge	Santa Clara: RWS GW	1998-2004	Monitored Pumping Wells	Lacks Data	1	-0.70	-0.70	-0.70	0	0.00	1	0.20
Santa Clara Subbasin Managed Recharge	Santa Clara: TW GW	1977-1980	Monitored Pumping Wells	Stable	7	0.23	0.40	0.00	7	0.65	0	0.00
Santa Clara Subbasin Managed Recharge	SJ Water Company East: TW	1978-1981	Monitored Pumping Wells	Increasing	11	0.27	1.00	-0.80	9	0.53	2	0.11
Santa Clara Subbasin Managed Recharge	SJ Water Company East: TW	1998-2001	Monitored Pumping Wells	Stable	10	-0.32	0.60	-1.00	3	0.54	7	0.28
Santa Clara Subbasin Managed Recharge	SJ Water Company North: GW	1978-1981	Monitored Pumping Wells	Increasing	11	0.17	1.00	-0.67	8	0.70	3	0.45
Santa Clara Subbasin Managed Recharge	Stanford: RWS	1978-1982	Monitored Pumping Wells	Increasing	1	1.00	1.00	1.00	1	0.25	0	0.00
Santa Clara Subbasin Managed Recharge	Stanford: RWS	2011-2013	Monitored Pumping Wells	Decreasing	4	-0.50	-0.33	-1.00	0	0.00	0	0.88

Activity	Pumping Area	Evaluation Period	Well Type	Visual Trend	Count of wells with n > 8	Average tau	Max tau	Min tau	Num tau >= 0	Average padj for tau >= 0	Num tau <0	Average padj for tau < 0
Treated Water Delivery	Great Oaks: GW	1975-1982	Monitored Pumping Wells	Stable	13	-0.18	0.45	-1.00	6	0.48	7	0.26
Treated Water Delivery	Great Oaks: GW	1998-2004	Monitored Pumping Wells	Decreasing	19	-0.29	0.60	-1.00	5	0.64	14	0.30
Treated Water Delivery	Great Oaks: GW	2009-2013	Monitored Pumping Wells	Decreasing	13	-0.21	0.44	-0.79	3	0.34	0	0.40
Treated Water Delivery	Milpitas: RWS	1975-1982	Monitored Pumping Wells	Increasing	3	-0.16	0.38	-0.58	1	0.11	2	0.19
Treated Water Delivery	Milpitas: RWS	1986-1991	Monitored Pumping Wells	Increasing	1	0.54	0.54	0.54	1	0.13	0	0.00
Treated Water Delivery	Morgan Hill: GW	1975-1982	Monitored Pumping Wells	Increasing	6	0.25	0.41	-0.02	5	0.22	1	0.95
Treated Water Delivery	Morgan Hill: GW	1986-1992	Monitored Pumping Wells	Decreasing	5	-0.31	-0.16	-0.38	0	0.00	5	0.29
Treated Water Delivery	Morgan Hill: GW	1998-2004	Monitored Pumping Wells	Decreasing	16	-0.28	0.33	-0.59	2	0.84	14	0.36
Treated Water Delivery	Morgan Hill: GW	2009-2013	Monitored Pumping Wells	Decreasing	2	0.23	0.67	-0.21	1	0.06	0	0.56
Treated Water Delivery	Mountain View: RWS	1986-1991	Monitored Pumping Wells	Increasing	5	-0.10	0.48	-0.81	2	0.29	3	0.51
Treated Water Delivery	Mountain View: RWS	1998-2000	Monitored Pumping Wells	Decreasing	3	-0.61	-0.33	-1.00	0	0.00	3	0.72
Treated Water Delivery	Mountain View: RWS	2001-2004	Monitored Pumping Wells	Stable	3	-0.47	0.20	-1.00	1	0.67	2	0.34
Treated Water Delivery	Mountain View: RWS	2009-2013	Monitored Pumping Wells	Decreasing	5	0.16	0.67	-0.33	3	0.35	1	0.81
Treated Water Delivery	North Morgan Hill:	1986-1992	Monitored Pumping Wells	Decreasing	7	-0.56	-0.02	-0.70	0	0.00	7	0.17
Treated Water Delivery	North Morgan Hill:	1999-2004	Monitored Pumping Wells	Decreasing	9	-0.46	0.00	-0.72	1	1.00	8	0.16
Treated Water Delivery	North Morgan Hill:	2010-2013	Monitored Pumping Wells	Decreasing	6	-0.43	-0.25	-0.60	0	0.00	0	0.47
Treated Water Delivery	Palo Alto: RWS	1975-1982	Monitored Pumping Wells	Increasing	8	0.70	0.82	0.57	8	0.02	0	0.00
Treated Water Delivery	Palo Alto: RWS	1986-1992	Monitored Pumping Wells	Decreasing	7	-0.58	0.21	-1.00	1	0.58	6	0.26
Treated Water Delivery	Palo Alto: RWS	1998-2002	Monitored Pumping Wells	Stable	3	-0.52	-0.26	-0.70	0	0.00	3	0.16
Treated Water Delivery	Palo Alto: RWS	2009-2013	Monitored Pumping Wells	Decreasing	4	-0.96	-0.86	-1.00	0	0.00	0	0.40
Treated Water Delivery	San Jose Muni: GW	1975-1982	Monitored Pumping Wells	Increasing	2	0.07	0.27	-0.14	1	0.23	0	0.50
Treated Water Delivery	San Jose Muni: GW	1986-1992	Monitored Pumping Wells	Decreasing	1	-0.55	-0.55	-0.55	0	0.00	0	0.12
Treated Water Delivery	San Jose Muni: RWS	1986-1992	Monitored Pumping Wells	Increasing	12	0.42	0.91	-1.00	9	0.12	1	0.43
Treated Water Delivery	San Jose Muni: RWS	2000-2003	Monitored Pumping Wells	Decreasing	2	0.67	0.67	0.67	2	0.25	0	0.00
Treated Water Delivery	San Jose Muni: RWS	2010-2012	Monitored Pumping Wells	Increasing	3	0.33	1.00	-1.00	2	0.38	0	0.62
Treated Water Delivery	Santa Clara: GW	1975-1982	Monitored Pumping Wells	Stable	13	-0.03	0.44	-0.56	5	0.50	8	0.52
Treated Water Delivery	Santa Clara: GW	1999-2001	Monitored Pumping Wells	Decreasing	14	-0.33	0.67	-1.00	4	0.74	0	0.55
Treated Water Delivery	Santa Clara: GW	2009-2013	Monitored Pumping Wells	Decreasing	18	0.26	0.67	-0.17	17	0.53	0	0.67
Treated Water Delivery	Santa Clara: RWS GW	1975-1981	Monitored Pumping Wells	Increasing	2	0.08	0.16	0.00	2	0.78	0	0.00
Treated Water Delivery	Santa Clara: RWS GW	1998-2004	Monitored Pumping Wells	Lacks Data	1	-0.70	-0.70	-0.70	0	0.00	1	0.20
Treated Water Delivery	Santa Clara: RWS GW	2011-2013	Monitored Pumping Wells	Decreasing	1	-0.33	-0.33	-0.33	0	0.00	0	0.82
Treated Water Delivery	J Water Company Los Gatos: Local SV	1979-1982	Monitored Pumping Wells	Stable	1	-0.14	-0.14	-0.14	0	0.00	1	1.00
Treated Water Delivery	J Water Company Los Gatos: Local SV	1998-2000	Monitored Pumping Wells	Decreasing	1	-1.00	-1.00	-1.00	0	0.00	1	0.30
Treated Water Delivery	J Water Company Los Gatos: Local SV	2001-2004	Monitored Pumping Wells	Decreasing	1	-0.33	-0.33	-0.33	0	0.00	1	0.54
Treated Water Delivery	J Water Company Los Gatos: Local SV	2009-2013	Monitored Pumping Wells	Decreasing	1	-0.47	-0.47	-0.47	0	0.00	0	0.32
Treated Water Delivery	SJ Water Company North: GW	1975-1982	Monitored Pumping Wells	Increasing	26	0.13	0.59	-1.00	21	0.25	5	0.48
Treated Water Delivery	SJ Water Company North: GW	2011-2013	Monitored Pumping Wells	Decreasing	3	-0.89	-0.67	-1.00	0	0.00	0	0.46
Treated Water Delivery	Stanford: RWS	1978-1982	Monitored Pumping Wells	Increasing	1	1.00	1.00	1.00	1	0.25	0	0.00
Treated Water Delivery	Stanford: RWS	1998-2001	Monitored Pumping Wells	Lacks Data	1	1.00	1.00	1.00	1	0.19	0	0.00
Treated Water Delivery	Stanford: RWS	2011-2013	Monitored Pumping Wells	Decreasing	4	-0.50	-0.33	-1.00	0	0.00	0	0.88
Llagas Subbasin Managed Recharge	Eastern Llagas:	1975-1982	Monitored Pumping Wells	Increasing	26	0.33	0.56	-0.50	24	0.17	2	0.64
Llagas Subbasin Managed Recharge	Eastern Llagas:	1988-1992	Monitored Pumping Wells	Decreasing	26	-0.13	0.47	-0.79	12	0.65	14	0.39
Llagas Subbasin Managed Recharge	Eastern Llagas:	1998-2004	Monitored Pumping Wells	Decreasing	41	-0.52	0.00	-1.00	1	1.00	0	0.13
Llagas Subbasin Managed Recharge	Gilroy: GW	1975-1982	Monitored Pumping Wells	Increasing	5	0.36	0.45	0.27	5	0.15	0	0.00
Llagas Subbasin Managed Recharge	Gilroy: GW	1998-2004	Monitored Pumping Wells	Decreasing	1	-0.65	-0.65	-0.65	0	0.00	40	0.03
Llagas Subbasin Managed Recharge	Gilroy: GW	2006-2010	Monitored Pumping Wells	Decreasing	2	-0.17	-0.13	-0.21	0	0.00	0	0.77
Llagas Subbasin Managed Recharge	Morgan Hill: GW	1975-1982	Monitored Pumping Wells	Increasing	1	0.35	0.35	0.35	1	0.12	0	0.00
Llagas Subbasin Managed Recharge	Morgan Hill: GW	1998-2004	Monitored Pumping Wells	Decreasing	12	-0.26	0.33	-0.55	2	0.84	10	0.39

Appendix H

Santa Clara Plain Groundwater Model Simulations Memo

DRAFT

Santa Clara Valley Water District

MEMORANDUM

TO: George Cook

FROM: Yaping Liu
Xiaoyong Zhan

SUBJECT: Santa Clara Plain Groundwater Modeling For the Zone of Benefit Study

DATE: August 5, 2016

The purpose of this memo is to summarize Santa Clara Plain groundwater model simulations performed for the Zone of Benefit study. Current Santa Clara Plain groundwater flow model is used to simulate groundwater conditions for six scenarios. The simulation period is from January 1970 to December 2015 with a monthly stress period for all scenarios. Table 1 summarizes modeling assumptions, input data, and the name of model output head files for each scenario. The simulation assumptions in Table 1 are only assumptions that are different from the baseline. The quantified differences are listed in Table 2. In addition, shapefiles that are related to modeling assumptions are saved in G:\GWMU_Projects\GW_Charge_Zone\ModelingResults\SantaClaraPlain\Shapefile.

Table 1. Modeling Summary

Scenario	Activity	Simulation Assumption	Output Head File
1	Baseline	➢ Pumping input data: actual data. ➢ Managed recharge input data: actual data. ➢ Treated water input data: actual data. ➢ Recycled water input data: actual data.	Scenario_1.hed
2	Treated water reduction	➢ Pumping input data: • Actual data from Jan. 1970 to Dec. 2015. • Additional pumping equal to one half of actual treated water of the same month in selected wells of retailers who received treated water from Jan. 1980 to Dec. 2015. ➢ Treated water input data: • Reduced treated water equal to one half of actual treated water volume of the same month from Jan. 1980 to Dec. 2015.	Scenario_2.hed
3	Managed recharge reduction 1	➢ Managed recharge input data: • Actual data from Jan. 1970 to Dec. 2004. • Actual import water data only (zero local water) from Jan. 2005 to Dec. 2015.	Scenario_3.hed
4	Managed recharge reduction 2	➢ Managed recharge input data: • Actual data from Jan. 1970 to Dec. 2004. • Actual local water data only (zero import water) from Jan. 2005 to Dec. 2015.	Scenario_4.hed
5	Managed recharge reduction 3	➢ Managed recharge input data: • Actual data from Jan. 1970 to Dec. 2004. • Zero from Jan. 2005 to Dec. 2015.	Scenario_5.hed
6	Recycled water reduction	➢ Pumping input data: • Actual data from Jan. 1970 to Dec. 2015. • Additional pumping equal to actual recycled water of the same month in Palo Alto system from selected retailer wells in Palo Alto area from Jan. 2000 to Dec. 2015. • Additional pumping equal to actual	Scenario_6.hed

		recycled water of the same month in Sunnyvale system from selected retailer wells in Sunnyvale area from Jan. 2000 to Dec. 2015. • Additional pumping equal to actual recycled water of the same month in South Bay Water Recycling (SBWR) from selected retailer wells in other Santa Clara Plain area ➢ Recycled input data: • Actual from Jan. 1970 to Dec. 1999. • Zero from Jan. 2000 to Dec. 2015.	

Table 2. Partial Input Data.

Scenario	2	3	4	5	6		
	Additional Pumping equal to 50% Treated Water Reduction	Managed Recharge Reduction 1	Managed Recharge Reduction 2	Managed Recharge Reduction 3	Additional Pumping equal to 100% Recycled Water Reduction from Jan. 2000 – Dec. 2015		
Year	From Jan. 1980 – Dec. 2015	Import Water Only	Local Water Only	Zero	Palo Alto Area	Sunnyvale Area	Other San Clara Plain Area
1980	36,139						
1981	35,341						
1982	33,569						
1983	36,410						
1984	39,920						
1985	40,103						
1986	40,190						
1987	46,896						
1988	52,527						
1989	59,623						
1990	52,596						
1991	48,575						
1992	46,822						
1993	50,968						
1994	51,289						
1995	53,414						
1996	60,270						
1997	66,178						
1998	61,016						
1999	65,409						
2000	64,843				64	317	4,842
2001	67,087				64	1,320	6,002
2002	71,884				76	1,347	6,355
2003	65,297				87	1,822	6,297
2004	67,314				263	1,844	7,191
2005	66,967	16,297	50,856	0	1,306	1,851	8,035
2006	65,811	18,043	50,983	0	1,549	1,928	8,734
2007	65,709	51,489	9,865	0	1,436	1,874	10,084
2008	62,524	35,111	19,439	0	1,513	1,230	10,321
2009	55,378	40,414	25,666	0	1,849	1,454	9,901
2010	54,099	22,609	35,934	0	2,827	1,518	8,612
2011	61,160	14,861	39,960	0	2,960	1,057	9,085
2012	68,174	35,532	20,410	0	3,075	640	11,586
2013	63,390	46,104	17,717	0	2,523	658	15,296
2014	45,751	4,973	5,976	0	3,243	947	20,345
2015	47,247	23,155	5,003	0	3,296	967	18,461

Appendix I

Llagas Groundwater Model Simulations Memo

Santa Clara Valley Water District

MEMORANDUM

TO: George Cook, Vanessa De La Piedra

FROM: Chanie Abuye

SUBJECT: Llagas subbasin modeling results for Groundwater Charge ZOB study

DATE: July 29, 2016

The purpose of this memorandum is to document the modeling assumptions and data used to run the Llagas groundwater flow model to support the groundwater charge zone of benefit (ZOB) study. Existing Llagas groundwater flow model is used to assess the subbasin groundwater condition using actual groundwater pumping and recharge data from the beginning of October 1987 to the end of 2015 in one month increments. The groundwater demands and recharge conditions are based on the asumptions provided in the attached excel sheet, which are also listed below.

Assumptions, Scenarios and Results

Using the modeling assumptions described in detail below, a total of five different model runs were performed to produce the model output and the model outputs in MODFLOW binary head file format are presented as follows:

Scenarios	Assumptions	Outputs or Results
Baseline	➢ Simulation period: Oct87 to Dec15 ➢ Actual groundwater pumping ➢ Actual recharge (managed and natural)	Baseline.hds
Scenario1: Eliminate local water managed recharge	➢ Simulation period: Oct87 to Dec15 ➢ Actual groundwater pumping ➢ Actual recharge (managed and natural): **Oct87 to Dec04** ➢ **Eliminate local water managed recharge: Jan05 to Dec15**	EliminateLocalWaterManagedRecharge.hds
Scenario2: Eliminate upper Llagas imported water managed recharge	➢ Simulation period: Oct87 to Dec15 ➢ Actual groundwater pumping ➢ Actual recharge (managed and natural): **Oct87 to Dec04** ➢ **Eliminate Upper Llagas imported water managed recharge: Jan05 to Dec15**	EliminateImportedWaterManagedRecharge.hds
Scenario3: Eliminate all managed recharge	➢ Simulation period: Oct87 to Dec15 ➢ Actual groundwater pumping ➢ Actual recharge (managed and natural): **Oct87 to Dec04** ➢ **Eliminate all managed recharge: Jan05 to Dec15**	EliminateAllManagedRecharge.hds
Scenario4: Increased groundwater pumping by	➢ Simulation period: Oct87 to Dec15 ➢ Actual recharge (managed and natural) ➢ Actual groundwater pumping: **Oct87 to Dec98**	IncreasedGWPumpingByAmountsOfRWDelivery.hds

amounts of recycled water (RW) delivery	➢ **Increased groundwater pumping by the amounts of monthly recycled water delivery: Jan99 to Dec15. A total of 58 groundwater pumping wells (Ag and MI) within half mile distance of the recycled water pipeline are used to distribute increased pumping evenly. 58 wells are selected from 2015 groundwater pumping distribution.**	

For reference purpose, measured and simulated groundwater hydrographs from model layer 1 for San Martin well are included in the attachment. The hydrographs are generated to confirm the model assumptions input data are reasonably applied into the model for the intended simulation period. A location map is also included in the attachment to provide the approximate location of recycled water pipeline, half mile buffer outline, instream recharge, percolation ponds, groundwater extraction wells and San Martin groundwater monitoring well in Llagas Subbasin.

Please let me know if you have any questions or comments regarding this memo or the attached files.

Attachments:

1. Baseline.hds
2. EliminateLocalWaterManagedRecharge.hds
3. EliminateImportedWaterManagedRecharge.hds
4. EliminateAllManagedRecharge.hds
5. IncreasedGWPumpingByAmountsOfRWDelivery.hds
6. LlagasSanMartinWellHydrographs
7. Location map of recycled water pipeline and other reference features in Llagas Subbasin

1. Baseline

Calendar Year	All managed recharge water in baseline model, AF	
2005	22,920	
2006	24,614	
2007	18,719	
2008	21,572	
2009	23,574	
2010	29,845	
2011	28,393	
2012	23,883	
2013	22,622	
2014	7,855	
2015	19,311	

Scenario 1. Eliminate Llagas local managed recharge

Calendar Year	Managed recharge water applied in the model, AF	Eliminated Llagas local managed recharge, AF
2005	9,820	13,100
2006	6,621	17,993
2007	12,736	5,983
2008	11,531	10,041
2009	9,668	13,906
2010	9,548	20,297
2011	7,672	20,721
2012	11,158	12,725
2013	11,601	11,022
2014	5,328	2,528
2015	10,713	8,599

Scenario 2. Eliminate Upper Llagas imported water managed recharge

CY	Managed recharge water applied in the model, AF	Eliminated Upper Llagas imported water managed recharge, AF
2005	18,408	4,512
2006	21,993	2,621
2007	9,844	8,875
2008	17,436	4,136
2009	19,254	4,320
2010	25,964	3,881
2011	25,410	2,983
2012	18,614	5,269
2013	17,179	5,443
2014	4,476	3,380
2015	13,612	5,699

Scenario 3. Eliminate all managed recharge

Calendar Year	Managed recharge water applied in the model, AF	Eliminated All Managed recharge Water, AF
2005	0	22,920
2006	0	24,614
2007	0	18,719
2008	0	21,572
2009	0	23,574
2010	0	29,845
2011	0	28,393
2012	0	23,883
2013	0	22,622
2014	0	7,855
2015	0	19,311

Scenario 4. Increased groundwater pumping by amounts of recycled water delivery, AF

Calendar Year	Increased Groundwater Pumping applied in the model, AF	Recycled water delivery, AF
1999	651	651
2000	746	746
2001	635	635
2002	495	495
2003	569	569
2004	1,162	1,162
2005	1,639	1,639
2006	1,782	1,782
2007	2,140	2,140
2008	2,183	2,183
2009	2,072	2,072
2010	1,761	1,761
2011	1,633	1,633
2012	1,940	1,940
2013	2,040	2,040
2014	2,015	2,015
2015	2,367	2,367

Appendix J

Simplification of Boundaries and Boundary Uncertainty

1814 Franklin St, Suite 501
Oakland, CA 94612

DRAFT TECHNICAL MEMORANDUM

To: George Cook, Santa Clara Valley Water District
From: Cameron Tana and Georgina King
Date: October 31, 2017
Subject: Possible Approach to Simplification of Boundaries and Boundary Uncertainty

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1. BACKGROUND

Technical Review Committee member Rebecca Nelson commented on the preliminary zone of benefit study on August 4, 2017 as follows:

> **Issue: simplification of boundaries**
> I understood the practical need to simplify complicated boundaries dictated by geology into something more amenable to efficient legal description. To help justify this process, it would be useful to give some indication/evidence of the difficulty/cost of having legal descriptions that mirror geological boundaries to head off any argument about arbitrariness of the simplified boundaries.
>
> I saw this as an area of particular challenge in terms of minimizing the number of pumpers on the margins of charge zones who might want to challenge the drawing of the boundaries. It seems desirable to try to head off as many of these challenges as possible at the outset. It would be possible to draw a link between the simplification of boundaries, and a spatial representation of the uncertainty of boundaries (see below), eg if a parcel of land lies mostly within an 'error band' around a particular boundary, a conservative approach may be to exclude it from a charge zone. This could be contrasted with a parcel of land, most of which lies within an area of high confidence as being within a zone of benefit on the basis of geology.
>
> **Issue: explicit treatment of uncertainty**
> It is worth mentioning that policy-related reports about groundwater seem to have an increasing tendency explicitly to reflect information about uncertainty, and

> how the uncertainty has been dealt with. Here, I distinguish uncertainty (eg relating to geological interpretation or using production wells for monitoring purposes) from conservative assumptions in terms of benefits (which I understand was the approach of the report). This is an unusual context for considering uncertainty, since it would not deal with uncertainty in terms of a variation in groundwater levels or volumes, but variation in a spatial boundary. I'm not entirely sure how one would represent it - but it would be worth some consideration. See one idea about the potential application of this to simplification of boundaries above.

This technical memorandum describes a possible approach to addressing these comments when simplifying boundaries for legal descriptions.

2. POSSIBLE APPROACH TO SIMPLIFICATION

As a response to this comment, we propose that simplification of boundaries does not result in any well included in a zone of benefit or a zone of benefit with higher groundwater charges as a result of the simplification. First note that simplification will only be applied to zone boundaries based on geologic boundaries as other boundaries such as the County, basin boundaries, and delivery areas generally consist of straight line segments. Therefore, we propose the simplified boundary will lie within the mapped geology that defines the zone of benefit. No well that is outside the mapped geology that defines the zone will be in the zone. This does mean there could be wells located in the mapped geology that could be excluded from the zone. This is a conservative approach given the uncertainty of the mapped geologic boundaries.

2.1. Possible Steps for Simplification

The methodology below details how this possible approach will be implemented. The methodology involves two basic steps:

1. Simplify the boundaries based on mapped geology using the Douglas-Peucker algorithim using a tolerance of 50 feet.
2. Shift simplified boundaries inwards at least 50 feet reducing size of zone.

A 50 foot simplification tolerance is selected to reduce number of line segments of the largest Zone A to under 2,000 line segments. Current Zone W-2 has approximately 1,750 line segments so a 50 foot tolerance achieves a similar level of generalization as the current zones. These are more lines than requested by Towill in its draft scope of work for defining metes and bounds (attached) for the largest zones so the cost of Towill's scope may be higher than estimated. This higher cost may be offset by the zones smaller than Zone A having less lines than the Towill assumptions.

With respect to step 2, boundaries are shifted inwards into the zone if the boundary is with non-zone area, i.e., at the outer edge of the total area of zones of benefit. If the boundary is between two zones, the boundaries are shifted inwards into the zone that is expected to have a higher groundwater charge because it is demonstrated to have benefits from more District activities:

- Where Zone A (treated water delivery and managed recharge) shares geologic boundaries with Zones B1 and B2 (treated water delivery only) and Zone C (managed recharge only), boundaries will be shifted into Zone A.
- Where Zone D (managed recharge from local runoff and imported water) shares geologic boundaries with Zone E (managed recharge from imported water), boundaries will be shifted into Zone D.

An inward shift of at least 50 feet was selected so that the simplified boundary would always be within the unsimplified zone of benefit boundary and within the mapped geologic boundary. An inward shift of greater than 50 feet could abe used that accounts for uncertainty, as discussed below.

2.2. Simplification Methodology Details

The polygon boundaries representing the zones of benefit will be simplified into a version with a reduced number of line segments to facilitate the creation of a zone boundary legal description or metes and bounds. The Douglas-Peucker algorithm in ArcMap will be used to simplify the zone of benefit boundaries. This algorithm retains critical points by identifying and removing relatively redundant vertices to simplify data. The algorithm is based on the Douglas-Peucker algorithm: Douglas, David and Peucker, Thomas, "Algorithms for the reduction of the number of points required to represent a digitized line or its caricature," The Canadian Cartographer. 10(2), 112–22 (1973). This simplification algorithm is preferred over the Wang-Müller algorithm also available in ArcMap. The Wang-Müller algorithm identifies and eliminates relatively insignificant bends to simplify data. Although it is more faithful to the input geometry than the Douglas-Peucker algorithm, its level of simplification is not enough for a simplified version that needs to limit the number of straight lines in the largest zone boundary (Zone A) to under 2,000 lines.

The simplification tolerance parameter value in the simplification algorithm determines the degree of simplification. The larger the tolerance, the more coarse the resulting geometry is. Smaller tolerances generate geometry more faithful to the input. Preliminary tests indicate that a tolerance of 50 foot may be optimal. This will limit the simplified polygons to being no more than 50 feet away from the unsimplified polygon boundaries. Once the simplification algorithm has been run, the outermost boundaries of the simplified lines will have some portions that are outside of the original polygons (but not more than 50 feet). These are areas where the unsimplified polygons are concave. To ensure that the simplified line is always within the unsimplified charge zone polygon and the mapped geology, we propose to shift the outermost boundaries inwards by at least 50 feet. This will ensure that wells within any zone are located where geology associated with the zone is mapped.

3. ACCOUNTING FOR UNCERTAINTY OF GEOLOGIC BOUNDARIES

In response to Rebecca Nelson's second comments, we attempt to identify uncertainty associated with the boundaries that define the preliminary zones of benefit. Then, we propose an adjustment to the simplification approach that accounts for uncertainty.

3.1. Sources of Uncertainty Associated with Zone Boundaries

Geologic boundaries on a map have several sources of uncertainty (Lark et al. 2015):

1. Conceptual uncertainty is "the uncertainty attached to a mapped boundary which represents a division of spatially continuous variation rather than a contact between two unambiguously different geological units". For example, this would occur where there is a lateral facies change.
2. Scale-dependent uncertainty occurs because "Even where a boundary is conceptually unambiguous, the precise position at which it should be described as a continuous line may depend on the spatial scale at which it is observed, and entails some degree of generalization of fine-scale variation".
3. Cartographic uncertainty is introduced when the geologist's mapped boundaries are converted to a cartographic product.
4. Interpretation uncertainty is the most obvious of the uncertainties and occurs when direct observation of a contact is not possible. Over most of the mapped length of a boundary, the line position is based on the mapper's interpretation of available information. Available information includes direct observation, geophysical surveys, inferring between observations, using constraining information such as topography. Therefore, the mapped position of the boundary is the geologist's best expert interpretation of the available information.

Conceptual, scale-dependent and cartographic uncertainty certainly exist in the geologic data from which the draft charge zones were derived, however they are not quantified by their mappers. Some of the data do have the interpreted uncertainty provided in map documentation or metadata. The table below summarizes the sources of data used to derive the draft charge zones. Some of these data have interpretation uncertainty specified in their map documentation or metadata, others have no mention of uncertainty.

<table>
<tr><th>Data Source</th><th colspan="2">Uncertainty Specified in Map Documentation</th><th>Measure of Uncertainty</th></tr>
<tr><td>Bedrock-Alluviumcontact</td><td colspan="2">1. contact, well located = depositional contact, location uncertainty less than about ±100 m
2. contact, approx. located = depositional contact, location uncertainty greater than about ±100 m</td><td>Attribute of each line in dataset from USGS</td></tr>
<tr><td>Geology (Santa Clara Formation and bedrock contacts)</td><td>San Jose 1:100,000
1. contact, certain
2. contact, approx. located
3. contact, inferred
4. contact, inferred, queried
5. contact, concealed
No other uncertainty metrics are provided in map documentation or metadata</td><td>Palo Alto 1:24,000
1. contact, certain
2. contact, approx. located
3. contact, concealed
No other uncertainty metrics are provided in map documentation or metadata</td><td>Not available</td></tr>
<tr><td>SCVWD Treated Water area</td><td colspan="2">The boundaries used for treated water areas were from a number of sources, some of which likely do not correspond with parcel boundaries. Reducing uncertainty of these areas could occur during process of defining metes and bounds.</td><td>Not available</td></tr>
<tr><td>County</td><td colspan="2">None – county line represents the true limit of the zone</td><td>No uncertainty</td></tr>
<tr><td>Alluvial cut offs</td><td colspan="2">These were delineated based on evaluation of surface elevation but removes areas of alluvium from the zone so more likely to conservatively exclude wells that benefit</td><td>Not available</td></tr>
<tr><td>DWR Basin boundary at Coyote Narrows</td><td colspan="2">The DWR basin boundary is based on the groundwater divide which changes over time. However, the basin boundary itself is a defined</td><td>No uncertainty</td></tr>
</table>

	legal boundary and represents the true boundary of the zone	

We have identified that the SCVWD treated water area data used for the draft charge zones is not fully accurate. Although, there is no measure of uncertainty for those boundaries, ensuring that the boundary aligns with the served parcels will improve accuracy and uncertainty considerably.

3.2. Adjustments to Possible Simplification Approach to Account for Uncertainty

In conclusion, we propose the following:

1. Shift simplified geologic boundaries by 100 meters inwards, instead of the 50 foot inward shift in the GIS example provided. The metric of 100 meters is the only measure of uncertainty we have in the geological data used to derive the draft charge zones.
2. Use unsimplified County boundary in north.
3. Use unsimplified DWR basin boundary at Coyote Narrows
4. Use parcel boundaries to delineate treated water areas. This will mean those boundaries will not need to simplified or shifted inwards.
5. Use unsimplified alluvial cutoffs.

4. REFERENCES

Lark, R. M., R. S. Lawley, A. J. M. Barron, D. T. Aldiss, K. Ambrose, A. H. Cooper, J. R. Lee, and C. N. Waters. 2015. *Uncertainty in mapped geological boundaries held by a national geological survey: eliciting the geologists' tacit error model.* Solid Earth, 6, p. 727–745. Web access: https://www.solid-earth.net/6/727/2015/se-6-727-2015.pdf

Preliminary geologic map of the San Jose 30 x 60 minute quadrangle, California. 1999. https://pubs.usgs.gov/of/1998/of98-795/of98-795_2a.txt

Geologic map and map database of the Palo Alto 30' X 60' quadrangle, California. 2000. https://pubs.usgs.gov/mf/2000/mf-2332/mf2332p.pdf

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TECHNICAL MEMORANDUM

DATE: August 15, 2019 **PROJECT #:** 9300.0606

TO: George Cook, Santa Clara Valley Water District

FROM: Cameron Tana

PROJECT: Valley Water Benefit Zone Study

SUBJECT: Implementation of Boundary Simplification and Modifications for Uncertainty

INTRODUCTION

Appendix J of the *Preliminary Groundwater Benefit Zone Study* (Montgomery & Associates, August 2019) report includes a technical memorandum titled “Possible Approach to Simplification of Boundaries and Boundary Uncertainty” that describes a possible approach to modifying the basin boundaries to meet the following two objectives:

1. Facilitate development of legal descriptions of the benefit zone boundaries with metes and bounds by simplifying the boundaries to reduce the number of line segments that make up the boundaries.
2. Account for geologic uncertainty.

This memorandum describes implementation of the approach in developing the proposed benefit zones. In general, the approach was implemented as described in the October 2017 memo, but additional adjustments were made. This memorandum will be added to Appendix J of the *Groundwater Benefit Zone Study* report to be presented to the Valley Water Board of Directors.

IMPLEMENTATION STEPS

The implementation steps were as follows:

1. Simplify the boundaries based on mapped geology using the Douglas-Peucker algorithim using a tolerance of 50 feet.

2. Shift simplified geologic boundaries by 100 meters inwards based on the only measure of uncertainty available in the geological data used to derive the draft benefit zones. This is the uncertainty specified in the USGS mapping of the bedrock-alluvium contact.

3. Remove "islands" created by the inward shift in step 2 that become disconnected with District activities. Figure 1 provides an example of this step. Step 2 removed the light blue area from Zone A, which left pink "islands" removed by this step.

4. Adjust Zone E boundaries with alluvium not directly downstream of District reservoirs such that they are at least 100 meters away from mapped bedrock/alluvium contact to account for geologic uncertainty. Figure 2 shows implementation of this step. Steps 1 and 2 removed the light blue areas from Zone E and this step removed the pink areas.Figure 1

5. Use unsimplified boundaries for treated water delivery areas based on GIS files provided by retailers. After shift of step 2, adjustments were required to ensure all treated water delivery areas were covered by zone A, B1, or B2 because groundwater users in these areas benefit from in-lieu recharge.

6. Reduce zone areas based on well logs indicating the well is screened in bedrock. This step is described in further detail in the next section.

7. Use the unaltered northern and southern Santa Clara County boundaries in north and south which represents the related extent of the District jurisdiction and subbasin boundaries.

8. Use the unaltered boundary between existing zones W-2 and W-5 at the Coyote Narrows to delineate the boundary between zones A and C.

9. Use the unaltered DWR boundary between the Santa Clara and Llagas Subbasins to delineate the boundary between zones C and D.

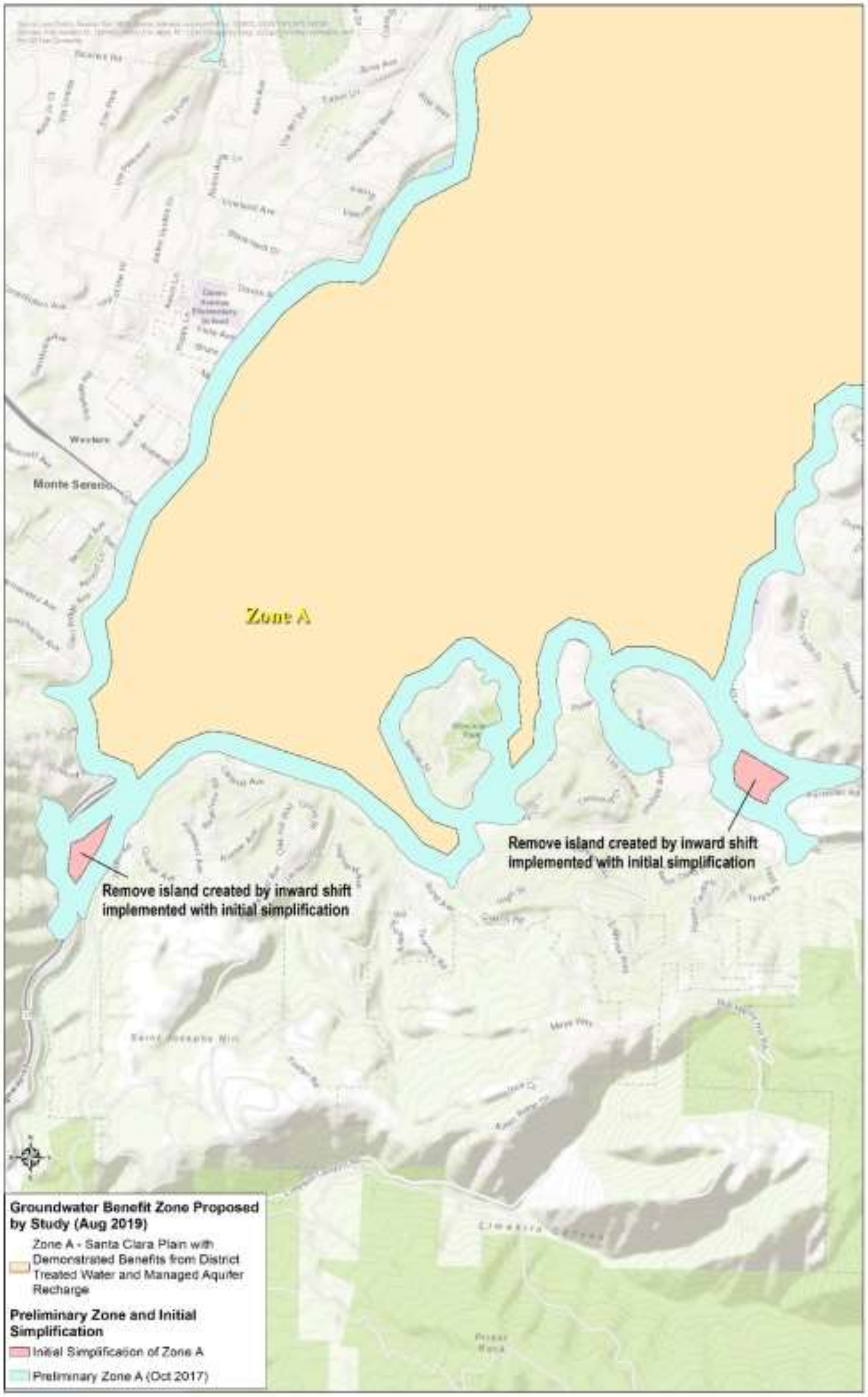

Monte Sereno
Zone A
Remove island created by inward shift implemented with initial simplification
Remove island created by inward shift implemented with initial simplification
Groundwater Benefit Zone Proposed by Study (Aug 2019)
Zone A - Santa Clara Plain with Demonstrated Benefits from District Treated Water and Managed Aquifer Recharge
Preliminary Zone and Initial Simplification
Initial Simplification of Zone A
Preliminary Zone A (Oct 2017)

Figure 1. Example of Implementation Step #3: Removal of “Islands” Created by Inward Shift

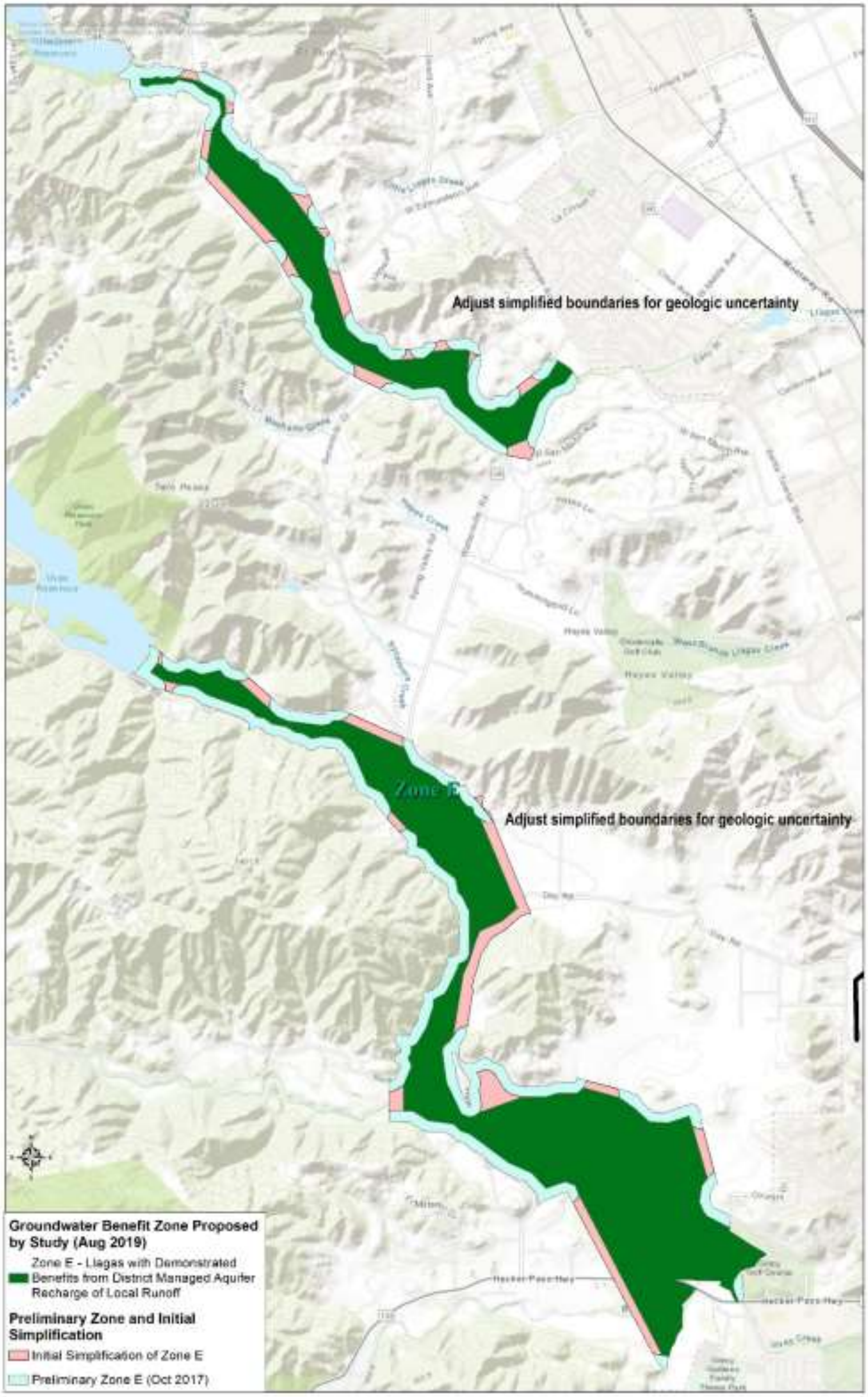
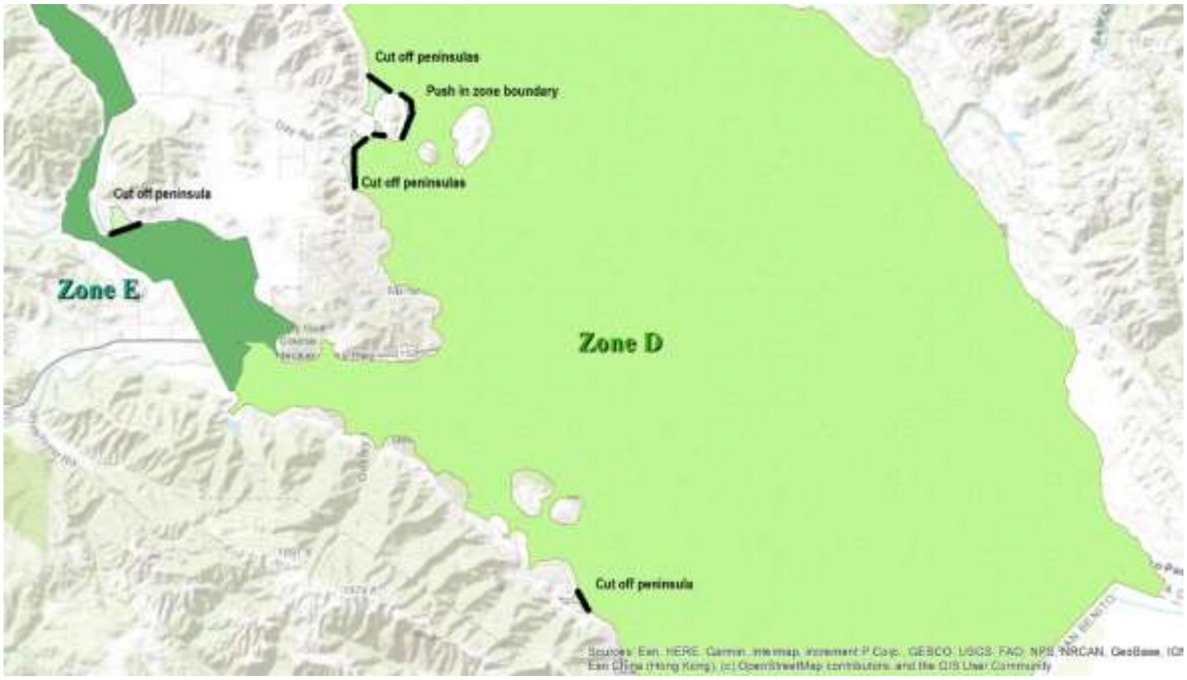

Adjust simplified boundaries for geologic uncertainty
Zone E
Adjust simplified boundaries for geologic uncertainty
Groundwater Benefit Zone Proposed by Study (Aug 2019)
🟩 Zone E - Llagas with Demonstrated Benefits from District Managed Aquifer Recharge of Local Runoff
Preliminary Zone and Initial Simplification
🟥 Initial Simplification of Zone E
▭ Preliminary Zone E (Oct 2017)

Figure 2. Implementation Step #4: Adjust Zone E Boundaries for Geologic Uncertainty

REDUCTION OF ZONE AREAS BASED ON WELL LOGS INDICATING BEDROCK

Step 6 above includes an additional evaluation beyond the originally proposed approach. In May 2019, the District provided 28 well logs for wells added to benefit zones based on steps 1-5, wells on the other side of the boundary from the added wells, and for a well whose owner previously requested exemption. Some of these logs indicate that the wells are screened in bedrock. In general, wells are considered screened in bedrock if the majority of the well screening was present in consolidated geologic material. Many of these wells are present in formations consisting of serpentine, shale, or strongly consolidated alluvium such as sandstone or mudstone. The assessment was based on geology of the actual screened intervals, rather than the borehole log as a whole.

Wells with logs indicating that they are screened in bedrock were removed from the zones by removing areas including the well locations. These areas included peninsulas of Zones D and E which were cut off to reduce the areas of Zones D and E. One well was removed by shifting the boundary of Zone D in from bedrock approximately 100 feet (Figure 3). In a treated water delivery area near Guadalupe Creek, a well was removed by cutting off a peninsula of Zone A to reduce the area of Zone A and increase the area of Zone B2 (Figure 4).



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IG
Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 3. Areas Removed from Zones D and E for Wells Screened in Bedrock

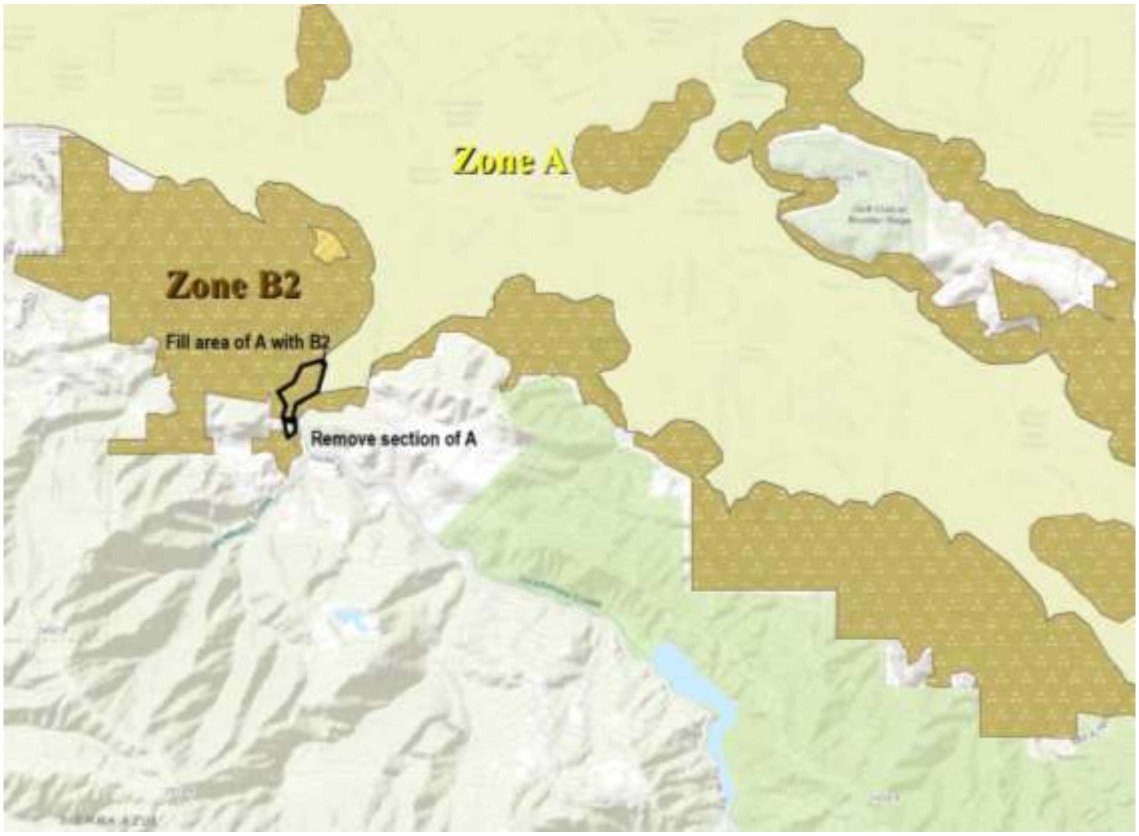


Figure 4. Areas Modified in Zones A and B2 for Well Screened in Bedrock

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SUMMARY OF BOUNDARY CHANGES

Table 1 summarizes where boundary adjustments were made for simplification and uncertainty purposes.

Table 1. Summary of Boundary Adjustments for Simplification and Uncertainty

Area 1	Area 2	Boundary	Simplification by Douglas-Peucker	Shift for Uncertainty	Adjust for Logs of Bedrock Well
Zone A	San Mateo County	County Line	No	No	No
Zone A	Non-Zone Alluvium	Alluvial Cutoff	No	No	No
Zone A	Non-Zone Bedrock	Unconsolidated Alluvium-Bedrock	Yes	Reduce Zone A	No
Zone A	Zone B1	Unconsolidated Alluvium-Santa Clara Formation	Yes	Reduce Zone A, Enlarge Zone B1	No
Zone A	Zone B2	Unconsolidated Alluvium-Bedrock	Yes	Reduce Zone A, Enlarge Zone B2	Reduce Zone A, Enlarge Zone B2
Zone A	Zone C	Zone W2-Zone W5	No	No	No
Zone B1	Non-Zone Alluvium	Alluvial Cutoff	No	No	No
Zone B1	Non-Zone Bedrock	Santa Clara Formation-Bedrock	Yes	Reduce Zone B1	No
Zone B1	Zone B2	Santa Clara Formation-Bedrock	Yes	Reduce Zone B1, Enlarge Zone B2	No
Zone C	Non-Zone Alluvium	Alluvial Cutoff	No	No	No
Zone C	Non-Zone Bedrock	Unconsolidated Alluvium-Bedrock	Yes	Reduce Zone C	No
Zone C	Zone D	DWR Santa Clara - Llagas Subbasin Boundary	No	No	No
Zone D	Non-Zone Alluvium	Alluvial Cutoff	No	No	No
Zone D	Non-Zone Bedrock	Unconsolidated Alluvium-Bedrock	Yes	Reduce Zone D	Reduce Zone D
Zone D	Zone E	Morgan Hill and Gilroy Boundaries	No	No	No
Zone D	San Benito County	County Line	No	No	No
Zone E	Non-Zone Alluvium	Alluvial Cutoff	No	Reduce Zone E	N
Zone E	Non-Zone Bedrock	Unconsolidated Alluvium-Bedrock	Yes	Reduce Zone E	Reduce Zone E

Appendix K

Groundwater Benefit Zone Exemption Process

HydroMetrics WRI

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Oakland, CA 94612

DRAFT TECHNICAL MEMORANDUM

To: George Cook, Santa Clara Valley Water District

From: Cameron Tana

Date: October 31, 2017

Subject: Groundwater Zone of Benefit Well Exemption Process

1. PURPOSE AND SCOPE

This memorandum provides a process for Santa Clara Valley Water District (District) staff to evaluate requests for exemption from a groundwater zone of benefit and, therefore, exempt water produced from the well from groundwater charges. The requests will be evaluated by the District staff to assess whether, in light of the submitted evidence, the District's determination to include the production well in the zone because it receives a benefit from District activities is reasonable and supported by evidence. The District staff's evaluation will be provided to the District's Board of Directors, which will decide whether the well should be exempt from the zone of benefit or re-assigned to a different zone of benefit.

2. GENERAL CHANGES FROM CURRENT PROCESS

This process includes the following general changes from the current process of groundwater charge zone modification, detailed in Document No. SOP465-103 from December 28, 2011:

1. This process assesses requests to exempt wells from a zone of benefit as opposed to exempting parcels. Document No. SOP465-103 provides a method for removing parcels from the zone of benefit.
2. Exemptions will be evaluated based on any relevant evidence that indicates the mapped boundary used to define the zone of benefit should be moved such that the well would be excluded from a zone or re-assigned to a different zone.
3. An evaluation that a well should be exempt from a zone of benefit will result in modification of zones of benefit but the modification will not be based on removing parcels from a zone of benefit. Instead, the modification will involve modification of zone boundary reflecting the relevant evidence indicating the

mapped boundary should be moved. The modification will also be consistent with boundary simplification approach used to facilitate legal descriptions of the zones. An example of a possible boundary simplification approach is summarized in section 9.2 and Appendix J of the Preliminary Zone of Benefit Study Report dated October 2017.

4. This process does not govern general modification of the zone of benefit resulting from changes to District activities or a revised understanding of the hydrogeology in the District, which is conducted pursuant to a separate process describing reviews of the zones of benefit.
5. The well may not be fully exempt from zones of benefit, and may be re-assigned with a different zone of benefit that is associated with a different set of District activities.

3. BASIS FOR WELL EXEMPTION

Wells will be exempted or re-assigned from zones of benefit based only any relevant evidence that the boundaries used to define the zones of benefit are not accurately mapped relative to the well location. The boundaries used to define the proposed zones are as follows (Section 8 of preliminary zone of benefit study report):

1. Bedrock/Alluvium contact
2. DWR basin boundary approximating groundwater divide between Santa Clara and Llagas Subbasins.
3. Coyote Narrows between Santa Clara Plain and Coyote Valley.
4. Santa Clara Formation outcrops.
5. Retailer areas where District treated water is delivered
6. Narrows between bedrock outcrops in Llagas Subbasin
7. Western boundaries of Morgan Hill and Gilroy.
8. Constrictions where alluvial channels are upstream of areas hydrogeologically connected to District activities.

There is uncertainty with these mapped boundaries, particularly with the geologic boundaries as discussed in Appendix J of the preliminary zone of benefit study. Local information at and around the well may show that the boundary is mapped incorrectly relative to the well. Any such local information will be evaluated to assess whether the boundary is mapped incorrectly and should be modified to exempt or re-assign the well.

Other approaches used to evaluate benefits in the zone of benefit study do not apply to individual wells. For example, groundwater elevations at a single well may not clearly demonstrate a benefit from District's activities, even if that benefit is occurring. As explained in the zone of benefit study, groundwater level benefits are evaluated by comparing groundwater level trends to the trends that would be expected if the District activity was not occurring. If a groundwater level trend is expected to decline without a District activity, a declining groundwater level trend could occur at any individual well even as a benefit from the District activity is demonstrated in the area based on multiple lines of evidence. Although groundwater level data from that well may not show an absolute improvement, a benefit is still realized because groundwater level declines would be greater without the District activity.

4. SUBMITTAL INFORMATION

The following information should be provided by the well owner requesting exemption or re-assignment:

- Well Owner Name
- Well Owner Mailing Address
- Well Owner Phone Number
- Well Owner Email Address (optional)
- Well Address or Parcel Number (if Different from Owner Mailing Address)
- Well Number
- Field Visit Request to Check Mapped Location or Observe Surficial Geology and Obtain Information Requested by Well Owner
- Claim of Geologic Formation (optional, e.g. bedrock, Santa Clara Formation)
- Any Relevant Information to Support Request

The well owner should also provide any other available documentation of the well's, nearby wells' or the area geology, such as drillers logs completed by a C-57-permitted drilling contractor, geologic logs by a registered California Professional Geologist, a geophysical logs, geophysical surveys, visual evidence of surface outcrops of geologic formations.

If the request for exemption is based on a claim that delivery area boundaries (i.e. retailer areas where District treated water is delivered and the western boundaries of Morgan Hill and Gilroy) are inaccurate relative to the well, the well owner should provide any available documentation supporting the claim.

5. DISTRICT EVALUATION PROCEDURE

5.1. Receive Request

The existing procedure for receiving a request in Document No. SOP465-103 from December 28, 2011 should continue to be followed. The main District activities in this step are:

- Compare submitted information to District records, including District copies of well logs.
- Confirm well is located in the correct groundwater zone of benefit and correct any discrepancies.

Before undergoing additional evaluation, the District should also confirm that a new evaluation of boundary near the well would change the well's zone of benefit assignment, based on the location of District activities assessed in the zone of benefit study. Some areas of bedrock have in-lieu benefits from the District's treated water deliveries to that area of the bedrock.

5.2. Field Visit

If requested in the submission, a District Professional Geologist will visit the well with the well owner present. The Professional Geologist should take the following actions on the visit:

- Compare well location with District mapped location.
- Record well coordinates with handheld Global Positioning System (GPS) unit
- Take photographs of well head and any surficial geologic features in surroundings
- Obtain any other information as requested by the well owner

Based on the field visit, District staff should update District records with any corrections to well locations and confirm the well is located in the correct groundwater zone of benefit. If the well is not located in the correct groundwater zone of benefit, any discrepancies should be corrected. Removing a well from a zone due to well location update is considered a record update as opposed to a well exemption requiring modification of the zone of benefit.

5.3. Conduct Evaluation of Boundary

If the well is located in the correct groundwater zone of benefit according to existing maps and the field visit, a Professional Geologist in the GMAU should conduct an evaluation of information pertaining to the boundary location. The evaluation will be based on information provided by the well owner, information in District records, and observations from a field visit.

Some geologic boundaries will be more difficult to evaluate than others. Identifying the various bedrock units should be relatively clear for evaluating the mapped location of the Bedrock/Alluvium contact, the location of Coyote Narrows, and the location of narrows between bedrock outcrops in the Llagas Subbasin. In contrast, identifying the Santa Clara Formation will likely be more challenging. Visual distinction between the Santa Clara Formation and Unconsolidated Alluvium can be difficult. To identify Santa Clara Formation, the Professional Geologist will compare the subject well information to well log information from nearby wells in the zone representing Santa Clara Formation, and in the zone representing Unconsolidated Alluvium. The Professional Geologist will make a professional judgement about which set of wells has geology most similar to the geology observed at the subject well. If the subject well is more like the geology of the wells in the Santa Clara Formation, boundary modification and well exemption or re-assignment should be evaluated. If the Professional Geologist is unable to make this distinction, the evaluation will conclude that the Santa Clara Formation has not been identified and boundary modification and well exemption or re-assignment should not be recommended.

To evaluate boundaries based on constrictions where alluvial channels are upstream of areas hydrogeologically connected to District activities, the Professional Geologist will evaluate information related to ground surface elevations, stream levels, and alluvial thicknesses. The Professional Geologist will make a professional judgement about whether these characteristics are more similar to the valley floor or the alluvial channels downstream of District reservoirs or alluvial areas that have been removed from the zone. If these characteristics around the well or more like areas that have been removed from the zone, boundary modification and well exemption or re-assignment should be evaluated. If the Professional Geologist is unable to make this distinction, the evaluation will conclude that alluvial channels upstream of areas hydrogeologically connected to District activities have not been identified and boundary modification and well exemption or re-assignment should not be recommended.

To evaluate boundaries based on retailer areas (areas that deliver District treated water, Morgan Hill, and Gilroy), GMAU staff will confirm information provided with the retailer and if the new information indicates that the boundary should be corrected, boundary modification and well exemption or re-assignment should be evaluated.

Boundary based on the DWR basin boundary representing the groundwater divide between the Santa Clara Plain and Llagas Subbasins will not be evaluated for adjustment based on local information. The groundwater divide is a regional characteristic of hydrogeology in the Basin and will not be revised based on local information. Evaluation of long-term changes to the groundwater divide will follow the process of zone of benefit review.

5.4. Modify Boundary and Recommend Exemption or Re-assignment

If the Professional Geologist determines that information warrants modification of the boundary, the Professional Geologist will recommend revised boundary based on all available information. The recommended boundary will also be consistent with boundary simplification approach used to facilitate legal descriptions of the zones. Based on the recommended revised boundary, the Professional Geologist will recommend whether the well should be in zone of benefit and what zone of benefit it should be assigned.

5.5. Documentation of Evaluation

District staff will produce a draft technical memorandum that includes:

- Summary of findings
- Comparison of submitted information to District records
- Documentation of field visit
- Evaluation of geologic data
- Recommendation of revised boundary modification if any
- Evaluation of zone exemption or re-assignment
- Appropriate figures with map locations and layers evaluated.

As directed in Document No. SOP465-103 , the draft technical memorandum will be reviewed by the Groundwater Management Unit manager and other appropriate staff, and comments from that review will be incorporated into a Final Technical Memorandum to be presented to Board for consideration

6. BOARD CONSIDERATION

The Board will consider input from the requestor and the evaluation and recommendation from Staff. If the Board approves a modification of the boundary, Staff will revise the metes and bounds. The revised metes and bounds will be taken to the Board for adoption.

Appendix L

Process to Conduct Future Reviews of Groundwater Benefit Zones

HydroMetrics WRI

1814 Franklin St, Suite 501
Oakland, CA 94612

DRAFT TECHNICAL MEMORANDUM

To: George Cook, Santa Clara Valley Water District

From: Cameron Tana

Date: October 31, 2017

Subject: Process to Conduct Future Reviews of Groundwater Zones of Benefit

1. PURPOSE AND SCOPE

This memorandum provides a process for Santa Clara Valley Water District (District) staff to conduct future reviews of the groundwater zones of benefit. It describes when the District Groundwater Monitoring and Analysis Unit (GMAU) should undertake reviews, and what those reviews should include. Reviews are based on changes to District activities and new information about hydrogeology in the District. All reviews should be documented, even if no modification of zones of benefit results. If the review results in a recommended modification to the zones of benefit, the recommendation will be presented to the District Board of Directors, and such a recommended modification will not take effect until approved by the Board. If approved by the Board of Directors, the modification will be codified by a revision of the zones' metes and bounds.

2. BACKGROUND

The preliminary draft zones of benefit are primarily defined based on demonstrated benefits from the two District activities: managed aquifer recharge and delivery of treated surface water. These are the District activities that are the largest contributors to Santa Clara County's water resources. In addition, the zones distinguish between managed aquifer recharge systems that only recharge local runoff and those that can also recharge imported water. Other District activities, such as recycled water delivery support, untreated surface water deliveries, indirect potable reuse, and potential direct potential reuse, provide a benefit but have contributions to the County's water budgets that are either small, difficult to measure, or difficult to separate from the benefits of the two primary District activities. Therefore these other activities were not used for defining zones of benefit in the preliminary zone of benefit study. However, changes to the location of these activities could change the zones of benefit. Therefore, although these other activities were not used to initially define zones of benefit, we have included a discussion in this document about ways in which they could modify the zones of benefit in the future.

3. GENERAL CHANGES FROM PROCESS FOR WELL EXEMPTION

This process includes the following differences from the current process of groundwater charge zone exemption, detailed in Document No. SOP465-103 from December 28, 2011, and the proposed process for well exemption (Appendix L of the preliminary zone of benefit study):

1. This process to review zones of benefit does not occur in response to requests for exemption from a zone of benefit from a well owner. A separate process describes exemption or re-classification of individual wells from a zone of benefit that focuses on local information that may justify revising zone boundaries near wells requested for exemption.
2. Currently, reviews are only initiated at District staff's discretion, and upon receipt of new information. This new process requires a review of zones of benefit if either of the following specified situations occur:
   a. Substantial changes to the type of District activities that provide the zone's benefits
   b. New hydrogeologic data become available

   Initiating review under these specified situations helps ensure the zones of benefit represent current District activities and the best available hydrogeologic information. The District can also set a scheduled interval to evaluate whether these specified situations have occurred.
3. The review tasks differ based on the situation that initiates the review.

4. ZONE OF BENEFIT REVIEW TRIGGERS

The preliminary draft zones of benefit are based on the areas where benefits are derived from the current locations of District activities. Therefore, the zones of benefit should be reviewed if existing District activities have a substantial geographic change, District activities are eliminated, or new District activities are added. Changes to the magnitude of District activities should not necessitate a review of zones of benefit.

The definition and extent of zones of benefit should be reviewed, and potentially revised, when any of the following changes to District activities occurs, or when any significant new hydrogeologic data become available.

4.1. Reviews Triggered by Changes to District Activities

Changes to any one of six District activities that provide groundwater benefits triggers a review of the zones of benefit when they entail a substantial geographic change. The definition of substantial geographic change is described for each activity in the following subsections.

4.1.1. Triggers Based on Changes to Managed Aquifer Recharge Programs

A substantial geographic change of the District's managed aquifer recharge activities would entail either:

- An addition or subtraction of managed aquifer recharge infrastructure that alters the geographic area benefited from managed aquifer recharge; or
- A change in the ability of a system to recharge imported water.

4.1.2. Triggers Based on Changes to Treated Water Delivery

A substantial geographic change of the District's treated water delivery area would entail a retailer adding or removing District treated water as a source of water for any of its service subareas. Adding or subtracting parcels or a subdivision to retailer's existing service subareas would not be considered a substantial geographic change in the alluvium areas because the area of hydrogeologic connection to treated water delivery areas will not have changed. However, adding or subtracting parcels or a subdivision to retailer's existing service subareas in bedrock would be considered a substantial geographic change because the zone of benefit boundary is based on the delivery area.

4.1.3. Triggers Based on Changes to Recycled Water Delivery

The preliminary draft zones of benefit are not based on the extent of demonstrated benefits from recycled water delivery. Instead, benefits from the District's recycled water activities are assigned to the existing zones of benefit in which the recycled water is delivered. Consistent with the zone of benefit study's assignment of recycled water activity to existing zones, the only substantial geographic changes that warrant a review of zones of benefit are:

- Removing an existing recycled water system from District activities; or
- Delivering recycled water to an area outside the zones currently receiving recycled water.

4.1.4. Triggers Based on Changes to Untreated Surface Water Delivery

The preliminary draft zones of benefit are not based on the extent of demonstrated benefits from the District's untreated surface water delivery. Instead, benefits from the District's untreated surface water delivery activities are assigned to the preliminary zones of benefit in which the untreated surface water is delivered. Untreated surface water delivery occurs to specific parcels, and was therefore considered not to be large enough to evaluate in the zone of benefit study. Consistent with the zone of benefit study, a substantial geographic change to untreated surface water delivery that warrants a review of the zones of benefit is delivery to an area outside the zones currently receiving untreated surface water.

4.1.5. Triggers Based on Changes to Indirect Potable Reuse Activities

The preliminary draft zones of benefit are not based on the extent of demonstrated benefits from planned indirect potable reuse; i.e., the replenishment of highly purified recycled water into the basin. Instead, the District's indirect potable reuse activities are assigned to preliminary draft zones based on existing and planned locations. A substantial geographic change to the planned locations may warrant a review of the zones of benefit.

4.1.6. Triggers Based on Changes to Direct Potable Reuse Activities

The preliminary draft zones of benefit are not based on the extent of demonstrated benefits from planned direct potable reuse. Instead, the District's planned direct potable reuse activities will be assigned to existing zones of benefit based on the location of the planned deliveries. A substantial geographic change to direct potable reuse activities that warrants a review of the zones of benefit is when the locations of the delivery areas for direct potable reuse are finalized.

4.2. Reviews Triggered by New Hydrogeologic Information

New hydrogeologic information may either change the District's understanding of groundwater flow within an existing zone of benefit or between adjacent zones of benefit. The triggering information for each of these two types of hydrogeologic information are described in the following subsections.

4.2.1. Triggers Based on Hydrogeologic Information within Existing Zones of Benefit

A new understanding that no reasonable basis supports the determination of a hydrogeologic connection within a zone of benefit could warrant subdividing the zone into multiple zones of benefit. The hydrogeologic information that would warrant a review of the zones of benefit include:

- Identifying a fault as a barrier to flow that could substantially reduce hydrogeologic connection within a zone;
- Identifying a pinching out of primary aquifer units; or
- Other information about subsurface geology that warrants substantial changes to an existing conceptual model of groundwater flow supporting a zone of benefit.

4.2.2. Triggers Based on Hydrogeologic Information between Existing Zones of Benefit

A new understanding of increased connection between zones of benefit could warrant expanding the zones, or combining multiple zones of benefit into a single zone. In some cases, such as the northern and southern boundaries of the Coyote Valley zone, new information could identify changed groundwater flow conditions. In other cases, such as the zones based on the extent of the Santa Clara Formation and Llagas and Uvas Creek Quaternary deposits west of Morgan Hill and Gilroy, new information could provide evidence of hydrogeologic connections with an adjacent zone where evidence of such a connection is currently lacking.

The hydrogeologic information that would warrant a review of the zones of benefit include:

- Changes to groundwater gradients at zone of benefit boundaries, such as the gradients in Coyote Narrows;
- Changes to the location of groundwater divides, such as that between Coyote Valley and Llagas Sub-basin;
- New hydrogeologic data in areas that lack any existing data, such as in and around the Santa Clara Formation;
- Changes to City service areas. The boundary of the zone of benefit representing the Quaternary deposits of Llagas and Uvas Creek with the zone of benefit representing the rest of Llagas Subbasin is partially based on the western boundaries of the cities of Morgan Hill and Gilroy. Without a documented geologic boundary in these areas, the cities' service area boundaries are used because the cities distribute groundwater pumped from the rest of the Llagas Subbasin throughout their systems. If the cities change the western boundaries of their service areas, the zone boundaries should be adjusted.

5. PROCESS FOR REVIEWING ZONES OF BENEFIT

The draft zones of benefit are based on available groundwater level, subsidence, and saltwater intrusion data measured over time, as well as groundwater modeling results where available. When changes are made to District activities, however, historical data regarding groundwater levels, subsidence, and saltwater intrusion will not be immediately available. As a result, it will be necessary to use other metrics to evaluate any resulting changes to the zones of benefit.

Groundwater modeling will be the preferred, primary tool, but can only be applied in areas where the groundwater model was adequate to define zones of benefit in the first instance. Groundwater modeling cannot be used to define the extent of benefits from District activities in certain circumstances, however. In particular, data and groundwater modeling results were not available when defining the zones of benefit in specific geologic formations. As described in the zones of benefit study, where modeling and data are not available, the preliminary draft zones of benefit are based on District activities occurring in those geologic formations and the interpreted hydrogeologic connection within those formations. In these areas where groundwater modeling is inadequate to define zones of benefit, the District will have to rely on evidence of hydrogeologic connections as the best available measure of changes in the geographic areas where wells are benefitted by District activities.

5.1. Zone of Benefit Reviews Using the Groundwater Model for Changes to District Activities

The following discussion applies to all areas where the groundwater model was adequate for defining zones of benefit.

Groundwater modeling should be performed in a manner consistent with modeling for the preliminary zone of benefit study. Model runs demonstrating the benefit of any substantial geographic change to District activity should be conducted for the same time period as the modeling in the zone of benefit study. Model runs simulating the changed District activity should be compared to model runs without the District activity to evaluate the extent of benefits from the changed District activity. Model runs will not evaluate the marginal effect of the changed activity by comparing the changed District activity to the unchanged District activity.

In general, the groundwater level results of the run with the changed District activities will be compared to the groundwater level results of the run performed for the zone of benefit study that simulates removal or reduction of District activities. If this comparison shows a substantial change in the area benefiting from the activity, the zone of benefit will be revised to reflect that substantial change.

Modeling for changes to specific District Activities are discussed in the following subsections.

5.1.1. Modeling Changes to Managed Aquifer Recharge Programs

The modeled groundwater levels incorporating the changed managed aquifer recharge activities should be compared to the modeled groundwater levels of the run performed for the zone of benefit study that simulates no managed recharge.

5.1.2. Modeling Changes to Treated Water Delivery Programs

The modeled groundwater levels incorporating changed pumping based on the changed delivery area will be compared to the modeled groundwater level of the run for the zone of benefit study that simulates increased pumping based on less in-lieu recharge throughout the current delivery area. The zone of benefit study assumed that the removal of delivered water would increase pumping in an amount equivalent to 50% of delivered water quantities. Modeling to reflect changes in District deliveries should be structured consistently, such that the addition of water deliveries to an area will decrease pumping by an amount equivalent to 50% of anticipated new deliveries, and the removal of water deliveries from an area will increase pumping by an amount equivalent to 50% of the removed deliveries.

5.1.3. Modeling Changes to Recycled Water Delivery Programs

If a recycled water system is removed from District supported activities, a model run will be conducted with increased pumping equaling the reduction of recycled water deliveries. If a recycled water system is added to District supported activities, a model run will be conducted with decreased pumping equaling the increase of recycled water deliveries. The modeled groundwater levels incorporating the changed pumping should be compared to the modeled groundwater levels of the run performed for the zone of benefit study that simulates no recycled water deliveries.

5.1.4. Modeling Changes to Untreated Surface Water Deliveries

The modeled groundwater levels incorporating reduced pumping due to changed untreated surface water deliveries should be compared to the results of another new run that simulates pumping without in-lieu recharge throughout the changed delivery area.

5.1.5. Modeling Changes to Indirect Potable Reuse

The modeled groundwater levels incorporating the pumping and injection changes related to new indirect potable reuse locations should be compared to the modeled groundwater levels of the historical baseline run performed for the zone of benefit study that simulates no indirect potable reuse.

5.1.6. Modeling Changes to Direct Potable Reuse

The modeled groundwater levels incorporating the pumping changes related to new deliveries of direct potable reuse water should be compared to the modeled groundwater levels of the historical baseline run performed for the zone of benefit study that simulates no direct potable reuse.

5.2. Modeling New Hydrogeologic Information

The model will also be used to model new hydrologic information where feasible.

5.2.1. Modeling New Hydrogeologic Information within Existing Zones of Benefit

New hydrogeologic data that suggest potentially reduced hydrogeologic connection within an existing zone of benefit should be incorporated into the District's groundwater model. Model simulations to compare runs with a District activity and with eliminated or reduced District activity should be performed with revised model. If model comparison results show a spatial break in areas where benefits occur from District activities, subdividing the zone into multiple zones may be warranted.

5.2.2. Modeling New Hydrogeologic Information between Existing Zones of Benefit

The District's groundwater model may be used to verify specific hydrogeologic changes between existing zones of benefit. These include:

- Verifying changes to groundwater gradients in Coyote Narrows will likely involve using runs of both the Santa Clara Plain and Coyote Valley groundwater models.
- Any new hydrogeologic data in areas that lack any existing data should be incorporated into the District's groundwater model to reflect the new hydrogeologic understanding. The revised groundwater model should be used to evaluate the revised extent of benefits from District activities.

5.3. Zone of Benefit Reviews Using Hydrogeologic Connections

The following discussion applies to all areas where the groundwater model was inadequate for defining zones of benefit.

For the areas where modeling of changed activities cannot be used to define the extent of benefits, changes to District activities must result in a review of the hydrogeologic connection between the District activity and the area in question based on assessment of hydrogeologically connected areas in the preliminary zone of study report. The report defined the Santa Clara Formation, Unconsolidated Alluvium of Coyote Valley and

Unconsolidated Alluvium along Llagas Creek and Uvas Creek west of cities of Morgan Hill and Gilroy as separate hydrogeologically connected areas that are not modeled. In general, the locations of any substantial geographic changes in District activities should be compared to the boundaries of these hydrogeologically connected areas to determine the geographic area and extent of impact from the change in District activities.

The following subsections address the review necessary for changes to specific District activities.

5.3.1. Managed Aquifer Recharge

In the preliminary draft zones of benefit, the geologic formations outside the models used for the study that receives a benefit from managed aquifer recharge included the Coyote Valley Unconsolidated Alluvium, and Llagas and Uvas Creek Unconsolidated Alluvium west of Morgan Hill and Gilroy. Removal of a managed aquifer recharge system could reduce the areas that has a hydrogeologic connection with managed aquifer recharge. Addition of a system could increase the areas that has a hydrogeologic connection with managed aquifer recharge.

5.3.2. Treated Water Delivery

In the preliminary draft zones of benefit, the geologic formation outside the models used for the study that receives a benefit from treated water delivery is the Santa Clara Formation. Removing District treated water as a source to a retailer subarea could reduce the area of the Formation that has a hydrogeologic connection with District's treated water.

In bedrock areas, the preliminary draft zones of benefit are based on the retailer areas receiving District treated water. If the retailer areas receiving District treated water in bedrock expand or contract, the zone of benefit should be revised to match those revised retailer areas.

5.3.3. Recycled Water Delivery

In the preliminary draft zones of benefit, there is no geologic formation outside the models used for the study receiving a benefit from recycled water deliveries. If recycled water is delivered to a new area outside all existing zones of benefit, the zones of benefit will need to be redefined to differentiate between the new area that is hydrogeologically connected to recycled water deliveries, and areas within the existing zones of benefit. If the areas within the existing zones of benefit receiving recycled water change, the zones of benefit will not change because it is defined by benefits from larger District activities but the assignment of recycled water benefits to zones will change.

If recycled water is delivered to bedrock in areas that do not match the areas in bedrock receiving treated water, the bedrock will have at least one additional zone that benefits from recycled water limited to the areas receiving recycled water.

5.3.4. Untreated Surface Water Delivery

In the preliminary draft zones of benefit study, the geologic formations receiving a benefit from untreated surface water deliveries included the Coyote Valley Unconsolidated Alluvium, and Llagas and Uvas Creek Unconsolidated Alluvium west of Morgan Hill and Gilroy. If the District delivers untreated surface water to a service area in non-bedrock areas, the zones of benefit will need to be redefined to differentiate between the new area that is hydrogeologically connected to the new untreated surface water deliveries and areas in the previous zones of benefit. If the areas within the existing zones of benefit receiving untreated surface water change, the zones of benefit will not change because it is defined by benefits from larger District activities but the assignment of untreated surface water benefits to zones will change.

Currently, deliveries of untreated surface water to parcels in bedrock areas are not assigned to zones of benefit. However, if untreated surface water is delivered to service areas in bedrock larger than parcels, those service areas will define a zone that benefits from this District activity. If the service areas receiving untreated surface water do not match the areas in bedrock receiving treated water, the bedrock will have at least one additional zone that benefits from untreated surface water limited to the areas receiving untreated surface water.

5.3.5. Indirect Potable Reuse

In the preliminary draft zones of benefit, the geologic formations receiving a benefit from indirect potable reuse included the Santa Clara Formation, Coyote Valley Unconsolidated Alluvium, and Llagas and Uvas Creek Unconsolidated Alluvium west of Morgan Hill and Gilroy. If the District expands its indirect potable reuse program to areas outside the existing zones of benefit, the zones of benefit will need to be redefined to differentiate between the new area that is hydrologically connected to the new indirect potable reuse deliveries and areas in the previous zones of benefit. If the areas within the existing zones of benefit where indirect potable reuse occurs or is planned change, the zones of benefit will not change because it is defined by benefits from larger District activities but the assignment of indirect potable reuse benefits to zones will change.

5.3.6. Direct Potable Reuse

If direct potable reuse delivery is established outside of existing zones of benefit, the zones of benefit will need to be redefined to differentiate between the new areas that are hydrogeologically connected to direct potable reuse and areas within existing zones of benefit. If no differences occur, the zones of benefit will not be revised; direct potable reuse will be assigned to the zone of benefit that is hydrologically connected to the direct potable reuse location. If the areas within the existing zones of benefit where direct potable reuse occurs or is planned change, the zones of benefit will not change because it is defined by benefits from larger District activities but the assignment of direct potable reuse benefits to zones will change.

5.4. Evaluating New Hydrogeologic Information in Areas that are not Modeled

Some new hydrogeologic information that becomes available may be related to the hydrogeologic connection outside the modeled area and will be assessed independently of the model.

5.4.1. New Hydrogeologic Information within Existing Zones of Benefit

For areas without groundwater level data or groundwater modeling results new hydrogeologic data could show less extent of connection within a geologic formation such as the Santa Clara Formation, Coyote Valley Unconsolidated Alluvium, and Llagas and Uvas Creek Unconsolidated Alluvium west of Morgan Hill and Gilroy. If the new understanding shows that some of these areas have substantially reduced hydrogeologic connection to locations of District activities, subdividing the zone into multiple zones is warranted.

5.4.2. New Hydrogeologic Information between Existing Zones of Benefit

Analyzing hydrogeologic connections between district activities and zones of benefit may be necessary to verify effects of new hydrogeologic data in specific areas. These include:

- Changes to the location of groundwater divides, such as that between Coyote Valley and Llagas Sub-basin will likely change the hydrogeologic connection between District activities and the boundaries of various zones of benefit
- Changes to City service areas will change the hydrogeologic connection between District activities and the boundaries of various zones of benefit

6. DOCUMENTATION

When the District determines that a review of the zone of benefit study is warranted and undergoes the review, the District should document the review in a draft technical memorandum with the following information for District Board consideration.

1. The situation that led to the review;
2. Summary of review evaluation, including new data, model results, and maps.
3. Recommended changes to zones of benefit, if any.

If the District Board approves a modification the zones of benefit, the District will revise the metes and bounds defining the zones.

Appendix M

Technical Review Committee Comments on Study

From: Rebecca Louise Nelson <rebecca.nelson@unimelb.edu.au>
Sent: Friday, August 04, 2017 3:33 AM
To: Cameron Tana
Subject: RE: SCVWD zone of benefit study draft comments by Friday

Dear Cameron,

Thanks for the reminder. And thanks again for involving me in the project - it has been incredibly interesting, and I heartily congratulate everyone involved!

More than adding anything new, these comments capture what I understood to be some very helpful statements that responded to the questions that I had during the teleconference. I think it would be great to include clarifying information to this effect in the report.

Issue: simplification of boundaries
I understood the practical need to simplify complicated boundaries dictated by geology into something more amenable to efficient legal description. To help justify this process, it would be useful to give some indication/evidence of the difficulty/cost of having legal descriptions that mirror geological boundaries to head off any argument about arbitrariness of the simplified boundaries.
I saw this as an area of particular challenge in terms of minimizing the number of pumpers on the margins of charge zones who might want to challenge the drawing of the boundaries. It seems desirable to try to head off as many of these challenges as possible at the outset. It would be possible to draw a link between the simplification of boundaries, and a spatial representation of the uncertainty of boundaries (see below), eg if a parcel of land lies mostly within an 'error band' around a particular boundary, a conservative approach may be to exclude it from a charge zone. This could be contrasted with a parcel of land, most of which lies within an area of high confidence as being within a zone of benefit on the basis of geology.

Issue: Exemption procedures
The report describes a process for a pumper to apply for an exemption from a charge zone, and that there would be a shift from granting exemptions by parcel to exemptions by well. It would be useful to include the explanation that the reason for this change was to align with a greater focus on geology in the rest of the charge zone rationale. It would also be worth explicitly considering how to deal with a situation where one parcel holder has multiple wells. One consideration may be the burden that would be borne by one parcel holder having to pay high costs of producing geological information for multiple wells.

Issue: explicit treatment of uncertainty
It is worth mentioning that policy-related reports about groundwater seem to have an increasing tendency explicitly to reflect information about uncertainty, and how the uncertainty has been dealt with. Here, I distinguish uncertainty (eg relating to geological interpretation or using production wells for monitoring purposes) from conservative assumptions in terms of benefits (which I understand was the approach of the report). This is an unusual context for considering uncertainty, since it would not deal with uncertainty in terms of a variation in groundwater levels or volumes, but variation in a spatial boundary. I'm not entirely sure how one would represent it - but it would be worth some consideration. See one idea about the potential application of this to simplification of boundaries above.

Issue: Benefits of conservation activities/demand management
I found this part of the report particularly fascinating. It would be worth including the clarification that these benefits are treated as uniform not only because they are dispersed throughout the relevant regions, but also because the rebates were equally available to all. This could help deal with any criticism that focuses on the distribution of the actual take-up

of these rebates, ie that the volumetric benefit of the rebates in the groundwater context might be spatially non-uniform (eg on account of larger areas of irrigated open space in some neighbourhoods that results in a rebate leading to greater conservation, or a different mix of imported surface water vs groundwater in different regions etc).

Again, thank you very much for involving me in the project. I very much look forward to seeing the next stages. I noted down that there would be a stakeholder meeting and a Board meeting in October and November - I look forward to seeing the results.

Best regards,
Bec

Dr Rebecca Nelson | Senior Lecturer
Melbourne Law School

Room 942, Level 9, 185 Pelham Street, Carlton VIC 3053 Australia
T: +61 3 8344 0436 E: rebecca.nelson@unimelb.edu.au
unimelb.edu.au

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-----Original Message-----
From: Cameron Tana [mailto:cameron@hydrometricswri.com]
Sent: Tuesday, 1 August 2017 3:13 AM
To: Carl Hauge <tuleluke@hcc.net>; Rebecca Louise Nelson <rebecca.nelson@unimelb.edu.au>; rebeccalouisenelson@gmail.com
Cc: George Cook <GCook@valleywater.org>; Laura Brown <laura@hydrometricswri.com>
Subject: RE: SCVWD zone of benefit study draft comments by Friday

Carl, Rebecca-

Thank you again for your participation and feedback last week on our call discussing this study. As requested, this is a reminder that we have requested written comments by this Friday, August 4. I look forward to seeing them. Thank you.

Best, Cameron

-----Original Message-----
From: Carl Hauge [mailto:tuleluke@hcc.net]
Sent: Sunday, July 23, 2017 9:52 AM
To: Cameron Tana <cameron@hydrometricswri.com>
Cc: Rebecca Louise Nelson <rebecca.nelson@unimelb.edu.au>; rebeccalouisenelson@gmail.com; George Cook <GCook@valleywater.org>; Laura Brown <laura@hydrometricswri.com>
Subject: Re: SCVWD zone of benefit study draft download

Cameron—I have downloaded the draft report and have started reviewing it. I have not yet looked at the appendices.

11 August 2017

To: Cameron Tana

From: Carl Hauge

Subject: Comments on draft report, *Santa Clara Valley Water District Zone of Benefit Study*

First of all I will say that the amount of data that you have collected, evaluated and displayed in hydrographs, graphs, cross-sections and maps is mind-boggling. However, such an effort is necessary if groundwater management is to be effective, and user fees for that management are to be assessed equitably. The report provides the detail necessary to determine in which areas action by the District benefits groundwater users, and the hydrographs give some idea of the scale of that benefit.

I have not looked into the methodology that was used by the agencies you describe in Appendix A to develop their zones of benefit. You have outlined a detailed, data-driven method. As we commented during our telephone committee meeting, the methodology used in this report will serve as an example for the Groundwater Sustainability Agencies formed under SGMA. SCVWD has a municipal revenue source. Not all agencies have such a source of revenue. Nevertheless, I think this report provides useful guidelines.

Finally I repeat that I think that you and the District have done a remarkable job of collecting the data that are available, collating it appropriately, evaluating it, and coming to defendable conclusions to establish the 6 zones of benefit you have delineated. You will no doubt get a lot of comments during your workshops, but what is important is that you have begun a process that can only lead to better water management. And we need a lot more of such leadership!

I hope my comments below are useful.

1. Listing what is known about the different hydrogeologic properties of different rock types provides realistic parameters for differentiating zones of benefit.

2. Using these properties your delineation of potential zones of benefit appears to be reasonable. In Section 4.1 you describe Quaternary Alluvium. You might want to consider including brief geologic – hydrogeologic descriptions of the Santa Clara Formation and what you are calling bedrock to give the reader some information about the rock types that surround the basins and their hydraulic properties.

3. Figure ES-3 is an important figure but the explanations at the bottom are essentially illegible (I think even to younger people). I suggest you print the map on 1 page and the explanations on a separate page in a larger font.

4. A list of the variables that must be considered in evaluating zones of benefit would help the reader better understand:

    a. the complexity of defining zones of benefit, and
    b. the degree of precision or lack of precision of each of the estimated properties or values.

5. My count of the variables that affect groundwater availability includes:

    a. local precipitation
    b. local recharge
    c. amount of treated water available
    d. amount of recycled water available
    e. amount of local surface water available
    f. water saved thru conservation
    g. amount of groundwater extracted
    h. change in groundwater levels
    i. groundwater quality (although I understand quality is not a consideration in evaluating zones of benefit in this report)
    j. actions of local retailing water agencies
    k. hydrogeologic connectivity of aquifers and rock types
    l. bedrock boundaries
    m. population affecting water use
    n. number of active wells in retail agency areas

6. I would expect that some of your deduced values will be challenged during the public hearing procedures.

7. While I understand why inclusion of water quality in your list of variables would add another level of complexity, I do not think that groundwater quality can be ignored. The bottled water industry is reaping millions of dollars because of people's concerns about drinking water quality. You might want to more effectively highlight the District's actions to protect water quality. The State Water Board's recent setting of an MCL for TCP as a result of contamination in San Joaquin Valley reinforces people's concerns.

8. Appendix A: The description of other agencies' adoption of zones of benefit is a very useful reference.

9. Other appendices containing hydrographs show trends that are useful in establishing benefits. Appendix C shows a very clear increase in groundwater levels in all pumping areas with increased treated water delivery; Appendix D shows a very clear decreasing trend of managed recharge in all pumping areas in the Santa Clara subbasin; Appendix E shows no decrease of managed recharge in the Llagas subbasin. These are excellent tools for understanding the effects of variations that require management because the affect groundwater levels and availability.

10. The data sets available to you cover relatively short periods of time. While these data are useful, data collected over a longer period of time might be more representative of the variable being monitored. However, you have to work with what is available. This is a good example of the need for long-term monitoring to more efficiently manage water resources.

11. Table 10 in the report: You might consider adding “subsidence” and “salt water intrusion.”

Appendix N

Stakeholder Comments and Responses to Comments on Study

Stanford University Comments and Valley Water Responses

Stanford University SUSTAINABILITY AND ENERGY MANAGEMENT

Vanessa De La Piedra, P.E. *via email to vdelapiedra@valleywater.org* March 23, 2018
Unit Manager, Groundwater Monitoring and Analysis Unit
SANTA CLARA VALLEY WATER DISTRICT
5750 Almaden Expressway
San Jose, CA 95118

Subject: Zones of Benefit Study

Dear Ms. De La Piedra:

Thank you for the opportunity to review the subject draft Zones of Benefit Study report. Stanford is reviewing the report, and is intending to prepare comments on it. Given the reliance of the study on a groundwater flow model in finding that benefits of SCVWD activities extend to the northern boundary of the Santa Clara Valley Basin, we would appreciate an opportunity to review additional information on the model used to determine Zones of Benefits, including:

1. Documentation of the original CH2MHill groundwater flow model (1991/2), and modifications thereto that were made in preparing the current findings and report;
2. Groundwater model files, along with descriptions of:
   a. The boundary conditions along San Francisquito Creek (the San Mateo – Santa Clara County line), and;
   b. Aquifer parameters.
3. Baseline and scenario assumptions, such as distinctions in the quantity of natural versus managed recharge in stream channels, that were assumed in deriving scenarios related to benefits; and
4. Thresholds of significance that were used in applying model results to Zones of Benefit findings.

Please let me know how we can receive or access this information, in order to complete our review and comments.

Sincerely,

Tom W. Zigterman

Tom W. Zigterman, P.E., D.DRE
Director, Water Resources & Civil Infrastructure

c: Rob Donlan, Ellison, Schneider, Harris and Donlan
Tom Elson, Luhdorff & Scalmanini
Peter Leffler, Luhdorff & Scalmanini

WATER RESOURCES & CIVIL INFRASTRUCTURE GROUP
327 Bonair Siding, Stanford, CA 94305-7272 T 650-725-8081 F 650-723-3191

From:	Mark Bilski
To:	Tom W Zigterman
Cc:	Vanessa De La Piedra; PublicRecords
Subject:	RE: Zones of Benefit Study - comment letter (RfPR#2018-3831) response
Date:	Monday, April 16, 2018 2:06:17 PM
Attachments:	Response to Stanford University Records Request RfPR.PDF image001.png

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Good Afternoon,

The remainder of your requested records are now available at the file share link: https://fta.valleywater.org/fl/9BwnP167z6. The attached pdf document provides additional brief text in response to your requests.

Should you have any concerns, please contact Records Management staff by email or by the phone numbers in my signature line below.

Kind regards,

Santa Clara Valley Water District

MARK BILSKI
STAFF ANALYST
Records & Library Services Unit
Santa Clara Valley Water District
5750 Almaden Expressway, San Jose CA 95118
Office: (408) 630-2830 | Hotline: (408) 630-2360
MBilski@valleywater.org
PublicRecords@valleywater.org
www.valleywater.org

From: Tom W Zigterman <twz@stanford.edu>
Sent: Wednesday, April 11, 2018 4:29 PM
To: Mark Bilski <MBilski@valleywater.org>
Cc: Vanessa De La Piedra <vdelapiedra@valleywater.org>; Lonnie Spin <LSpin@valleywater.org>; PublicRecords <PublicRecords@valleywater.org>
Subject: RE: Zones of Benefit Study - comment letter (RfPR#2018-3831) extension

Thank you, Mark!
-Tom

From: Mark Bilski [mailto:MBilski@valleywater.org]
Sent: Wednesday, April 11, 2018 1:56 PM
To: Tom W Zigterman <twz@stanford.edu>
Cc: Vanessa De La Piedra <vdelapiedra@valleywater.org>; Lonnie Spin <LSpin@valleywater.org>; PublicRecords <PublicRecords@valleywater.org>
Subject: RE: Zones of Benefit Study - comment letter (RfPR#2018-3831) extension

Tom: the record has now been added to the file share: https://fta.valleywater.org/fl/9BwnP167z6

Santa Clara Valley Water District

MARK BILSKI
STAFF ANALYST
Records & Library Services Unit
Santa Clara Valley Water District
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From: Mark Bilski
Sent: Wednesday, April 11, 2018 1:45 PM
To: Tom W Zigterman <twz@stanford.edu>
Cc: Vanessa De La Piedra <vdelapiedra@valleywater.org>; Lonnie Spin <LSpin@valleywater.org>; PublicRecords <PublicRecords@valleywater.org>
Subject: RE: Zones of Benefit Study - comment letter (RfPR#2018-3831) extension

Hi Tom,

We will check to see if we can locate that record.

Thank you,

Santa Clara Valley Water District

MARK BILSKI
STAFF ANALYST
Records & Library Services Unit
Santa Clara Valley Water District
5750 Almaden Expressway, San Jose CA 95118
Office: (408) 630-2830 | Hotline: (408) 630-2360
MBilski@valleywater.org
PublicRecords@valleywater.org
www.valleywater.org

From: Tom W Zigterman <twz@stanford.edu>
Sent: Wednesday, April 11, 2018 11:06 AM
To: Lonnie Spin <LSpin@valleywater.org>; Mark Bilski <MBilski@valleywater.org>
Cc: Vanessa De La Piedra <vdelapiedra@valleywater.org>
Subject: FW: Zones of Benefit Study - comment letter (RfPR#2018-3831) extension

Hi Lonnie and Mark:
See below – can you provide this CH2M Hill document?

-Tom

From: Pete Leffler [mailto:pleffler@lsce.com]
Sent: Wednesday, April 11, 2018 10:36 AM
To: Tom W Zigterman <twz@stanford.edu>; Tom Elson <telson@lsce.com>; Rob Donlan (red@eslawfirm.com) <red@eslawfirm.com>
Subject: RE: Zones of Benefit Study - comment letter (RfPR#2018-3831) extension

Hi Tom,

I have completed an initial review of the modeling TM; however, a complete review will be difficult without a document that is commonly referred to and referenced in the model TM. This document (listed below) appears to provide much of the detail related to the basis for construction of the model. If possible, it would be very helpful to obtain a copy of this document.

CH2M HILL (Nick Johnson). 1992a. Santa Clara Valley Groundwater Model Project. Hydrogeological Interpretation Draft Technical Memorandum. Prepared for the City of San Jose and Santa Clara Valley Water District. July 2.

Peter M. Leffler P.G., C.Hg.
Principal Hydrogeologist
Luhdorff & Scalmanini Consulting Engineers
505 14th Street, Suite 945
Oakland, CA 94612
530-661-0109 (main)
530-207-5761 (direct)
pleffler@lsce.com
www.lsce.com

From: Tom W Zigterman <twz@stanford.edu>
Sent: Monday, April 2, 2018 6:14 PM
To: Tom Elson <telson@lsce.com>; Rob Donlan (red@eslawfirm.com) <red@eslawfirm.com>; Pete Leffler <pleffler@lsce.com>
Subject: FW: Zones of Benefit Study - comment letter (RfPR#2018-3831) extension

Hi Tom and Pete:
Here's what I just received from SCVWD. It's from 2014…
-Tom

From: Mark Bilski [mailto:MBilski@valleywater.org]
Sent: Monday, April 2, 2018 4:48 PM
To: Tom W Zigterman <twz@stanford.edu>
Cc: Vanessa De La Piedra <vdelapiedra@valleywater.org>; Lonnie Spin <LSpin@valleywater.org>;

PublicRecords <PublicRecords@valleywater.org>
Subject: RE: Zones of Benefit Study - comment letter (RfPR#2018-3831) extension

Good Afternoon,

As a partial response to your records request, the documentation of the original CH2MHill groundwater flow model (the first part of your item 1) is available at the following file share link: https://fta.valleywater.org/fl/9BwnP167z6. Please note that although this document is marked "Draft," there is no final version, and this is representative of the model delivered by CH2MHill.

We continue to search for the records requested in your other items, however due to the need to search for and collect the requested records from field facilities or other establishments that are separate from the office processing the request, we will require more time to locate the responsive materials.

We hope to have a full response available for you shortly, but at the outside we anticipate being able to release any responsive records by April 16th. Should you have any concerns, please contact Records Management staff by email or by the phone numbers in my signature line below.

Kind regards,

Santa Clara Valley Water District

MARK BILSKI
STAFF ANALYST
Records & Library Services Unit
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PublicRecords@valleywater.org
www.valleywater.org

From: Tom W Zigterman <twz@stanford.edu>
Sent: Tuesday, March 27, 2018 7:52 PM
To: Lonnie Spin <LSpin@valleywater.org>
Cc: PublicRecords <PublicRecords@valleywater.org>
Subject: RE: Zones of Benefit Study - comment letter (RfPR#2018-3831)

Thank you, Lonnie!
-Tom

From: Lonnie Spin [mailto:LSpin@valleywater.org]
Sent: Tuesday, March 27, 2018 11:58 AM
To: Tom W Zigterman <twz@stanford.edu>
Cc: PublicRecords <PublicRecords@valleywater.org>

Subject: RE: Zones of Benefit Study - comment letter (RfPR#2018-3831)

Vanessa De la Piedra forwarded your request to me, and I just wanted to let you know that my unit has received it today. We are beginning to process your request, and will have a response for you as promptly as possible.

If you have any further questions concerning your request, please write to our PublicRecords@valleywater.org address so that we will be able to respond promptly. I will be out of office from April 2-6, however, records staff will be available to address all correspondence sent to the PublicRecords account.

Thank you,

LONNIE SPIN
RECORDS & LIBRARY UNIT MANAGER
Records & Library Services Unit
Santa Clara Valley Water District
5750 Almaden Expressway, San Jose CA 95118
(408) 630-2947
lspin@valleywater.org
www.valleywater.org
For records requests, please use:
PublicRecords@valleywater.org

Response to Stanford University Records Request RfPR#2018-3831
(Stanford request numbered, with District response in blue)

1. Documentation of the original CH2MHill groundwater flow model (1991/2), and modifications thereto that were made in preparing the current findings and report;

   District Response:

   Documentation of the groundwater flow model in the form of two CH2MHill reports was provided on 4/2/18 and 4/11/18.

   The District has made several modifications to the groundwater flow model since 1992 that are not documented in the reports provided. These changes are listed below.
   - Changed the model stress period from quarterly to monthly
   - Updated the top elevation of the model to match new land surface elevation data based on local LIDAR (Light Detection and Ranging) and USGS Quadrangle Map data
   - Reduced the head value as boundary condition at the Coyote Narrows to represent historical groundwater elevation
   - Increased the hydraulic conductivity value along the Los Gatos channel
   - Increased the specific yield value in the unconfined area along lower Los Gatos Creek, west of Guadalupe River and east of Saratoga Creek, between I-280 in the north and I-85 in the south

2. Groundwater model files, along with descriptions of:
   a. The boundary conditions along San Francisquito Creek (the San Mateo-Santa Clara County line), and;
   b. Aquifer parameters

   District Response:

   The groundwater model files are provided in a folder named “Model_Files.”

   The model coordinate system is in NAD 1983 State Plane California III FIPS 0403 (US Feet). The origin x,y coordinates and rotation are:
   - Origin coordinate X:6033315.129
   - Origin coordinate Y:1960607.1277
   - Rotation (degrees): -29.3

   The boundary conditions and aquifer parameters can be viewed for each model cell in the model files provided. Descriptions of the boundary conditions and aquifer parameters can be found in the CH2MHill Report “Santa Clara Valley Groundwater Model Project, Basinwide Groundwater Flow Model, Draft Technical Memorandum” dated December 1992. This was provided to Stanford on 4/2/18, noting that there is no final version, and the “Draft” report is representative of the model delivered by CH2MHill.

3. Baseline and scenario assumptions, such as distinctions in the quantity of natural versus managed recharge in stream channels, that were assumed in deriving scenarios related to benefits; and

District Response:

The baseline and scenario assumptions for the Santa Clara Plain simulations are described in Section 7.2 and Appendix H of the Preliminary Groundwater Zones of Benefit Study report by Hydrometrics WRI (October 2017).

4. Thresholds of significance that were used in applying model results to Zones of Benefit findings.

District Response:

The Preliminary Groundwater Zones of Benefit Study report describes the groundwater modeling approach (Section 7.1) and evaluation (Section 7.3), which notes the use of the model to "confirm and supplement demonstration of benefits by the groundwater level evaluation." Section 7.3.1 discusses how the model results were used in the evaluation of benefits in the Stanford area.

Stanford University SUSTAINABILITY AND ENERGY MANAGEMENT

Vanessa De La Piedra, P.E., Unit Manager *via email to vdelapiedra@valleywater.org* May 11, 2018
George Cook, Specialist *via email to gcook@valleywater.org*
Groundwater Monitoring and Analysis Unit
SANTA CLARA VALLEY WATER DISTRICT
5750 Almaden Expressway
San Jose, CA 95118

Subject: Zones of Benefit Study – Stanford comments

Dear Ms. De La Piedra and Mr. Cook:

Thank you for the opportunity to review the subject draft Zones of Benefit Study report, and for supplying additional information in response to our March 23 letter. We and our consultants, Luhdorff & Scalmanini Consulting Engineers (LSCE), have prepared technical comments on the study – see the accompanying LSCE Technical Memorandum dated May 7, 2018.

This Technical Memorandum enumerates several major concerns about the study's approach to modeling regional groundwater and particularly the study's conclusion that SCVWD groundwater recharge activities (that are several miles away from Stanford and the San Francisquito Cone) benefit the Stanford area. Stanford has long maintained that no demonstrable benefit from SCVWD groundwater recharge activities exists, and therefore the groundwater pumping fees are unjustified. Notwithstanding the flawed modeling approach, the Zone of Benefit Study fails to substantiate any material benefit from SCVWD's groundwater augmentation and management activities.

We would welcome an opportunity to discuss our comments in more detail with you and your consultant, particularly because several SCVWD groundwater staff are new and were not involved in Stanford's prior discussions with SCVWD on these matters several years ago. In light of the identified flaws with the Study and modeling approach, we urge SCVWD to hold off on finalizing the Study or using the Study to support decisions regarding groundwater management or pumping fees until these significant comments are addressed.

Please let me know some dates and times that we can meet. We look forward to continuing our discussions and reaching appropriate conclusions on this important issue.

Sincerely,

Tom W. Zigterman

Tom W. Zigterman, P.E., D.DRE
Director, Water Resources & Civil Infrastructure

c: Rob Donlan, Ellison, Schneider, Harris and Donlan
Tom Elson and Peter Leffler, Luhdorff & Scalmanini Consulting Engineers
Karla Daily, Palo Alto

Technical Memorandum

DATE: May 7, 2018 PROJECT: 14-2-067

TO: Tom Zigterman
Stanford University

FROM: Peter Leffler and Tom Elson

SUBJECT: **PRELIMINARY REVIEW COMMENTS ON SCVWD ZONE OF BENEFITS STUDY**

Luhdorff & Scalmanini Consulting Engineers (LSCE) was requested by Stanford University to review the Santa Clara Valley Water District (SCVWD) Draft Zone of Benefits (ZOB) study dated October 2017. Our review of the ZOB study included a request of selected supporting documents and model files from SCVWD. The requested model reports were subsequently provided to Stanford University along with a portion of the requested model files. Our review comments provided below relate to the ZOB study, the referenced supporting model documentation, and the subset of model files that were provided in response to Stanford's data request.

1) It is important to note that the Zone of Benefits (ZOB) study provides for inclusion of the Stanford area in the ZOB based primarily on groundwater model simulation results. The groundwater level data analysis method, utilizing data only from a 2011 to 2013 time period, was clearly of insufficient duration to prove a benefit to the Stanford area. Due to lack of evidence from the groundwater level analysis, it is very important to evaluate model characteristics and consider likely accuracy of groundwater model predictions in the Stanford area.

2) Our review of all available groundwater level data for the five Stanford wells (the ZOB study only uses three wells) shows a net stable to decreasing trend in water levels during the one evaluation period (2011-2013) used in the study. This is in contrast to the ZOB study claim of stable groundwater levels in the Stanford area during this time (page 68). Furthermore, there was a decreasing water level trend in the adjacent Palo Alto area (Table 8, page 67 of ZOB study) for the 2011-2013 evaluation period. Stanford and Palo Alto overlie a distinct physiographic area in the Santa Clara Valley known as the San Francisquito Cone. Thus, groundwater level trends in Palo Alto and Stanford should be interpreted together as being representative of the Cone, as such, groundwater level trends indicate a definite lack of benefit from District recharge and management activities.

3) The model uses no-flow boundaries along San Francisquito Creek, which also represents the County line and a jurisdictional boundary between Santa Clara Valley Groundwater Basin and San Mateo Plain Groundwater Basin. The justification provided in the Hydrogeologic Interpretation TM for using a no-flow boundary here is it represents a groundwater divide. However, this is poor justification for use of a no-flow boundary condition at this location because it artificially increases model-predicted changes in groundwater levels in the Stanford area from SCVWD recharge activities to the south. This is because the induced stress cannot be dissipated across the County line as will happen in reality (i.e., some of the change in groundwater levels will occur north of the County line and result in less change in groundwater levels in the Stanford area). In summary, the accuracy of model predictions will tend to be poor along model boundaries (especially along no-flow boundaries) compared to locations in the interior of the model domain and this is especially germane to conclusions of benefits in the Stanford-Palo Alto area.

4) The Model Hydrogeologic Interpretation TM states the groundwater model project area includes the southern half of the San Francisquito Cone/Subarea (pages 4-1 to 4-4), which is an area that includes Stanford University. DWR Bulletin 118 describes the Stanford area as part of the San Francisquito alluvial cone. San Francisquito Creek flows through the middle of the alluvial cone and is underlain by the most permeable sediments in the cone, which suggest this location is a poor choice for a model boundary location for the stated purposes of the ZOB study. Given the distinct hydrogeologic features of the San Francisquito Cone and Subarea, the model domain should have included the full extent of the San Francisquito Cone (extending north to Redwood City) and utilized different boundary conditions, such as general head, along the northern boundary of the model to more accurately represent the Stanford area and provide more accurate and reliable model predictions in this area. The incorporation of only half of San Francisquito Cone in the model domain and installation of a no-flow boundary through the middle of the Cone results in poor model simulation results in the Stanford area for the ZOB study.

5) Review of model files relative to horizontal hydraulic conductivity (K) in the Stanford area indicate values in the range of 5 to 10 feet/day. These K values are relatively low compared to site-specific studies and data evaluated by LSCE. Available data for the main portion of San Francisquito Cone indicate hydraulic conductivity values on the order of 10 to 85 feet/day for sediments in the depth range of 150 to 600 feet below ground surface. Use of lower than actual K values in the model will tend to result in overestimation of changes in groundwater levels in the Stanford area, thus over estimating effects from SCVWD recharge activities to the south.

6) Review of model files relative to specific yield (Sy) and storage coefficient (S) values in the Stanford area indicate a uniform Sy value of 0.07 and a uniform S value of 0.0001. These aquifer storage properties represent relatively low values and will tend to result in overestimation of changes in groundwater levels in the Stanford area, thus over estimating effects from SCVWD recharge activities to the south.

7) Based on review of model documentation reports, it does not appear that the model incorporates any stream percolation from San Francisquito Creek where there is a connection to the unconfined aquifer. Given the permeable nature of surficial sediments along upper reaches of San Francisquito Creek, it is expected that natural stream percolation may be a substantial source of water for the Stanford area. It is also not clear if the model accounted for artificial recharge in Lake Lagunita on the Stanford University Campus and irrigation return flows from application of SFPUC system surface water. The apparent lack of accounting for these sources of

recharge to the Stanford area would tend to result in overprediction of the effects of SCVWD recharge activities to the south. The model files provided to us did not include recharge inputs to the model, so this aspect of the model could not be verified.

8) Based on review of model documentation reports, there were no wells in the Stanford area used in model calibration. In addition, the model calibration period began in 1970, and does not capture the maximum period of basin stress in the early 1960's. Stanford area groundwater levels had already recovered approximately 100 feet due to import of SFPUC system water by Palo Alto and Stanford by the beginning of the model calibration period in 1970. These factors result in greater uncertainty regarding the validity of model predictions in the Stanford area.

9) The nearest SCVWD recharge facility is approximately nine and a half miles south of the Stanford area. There was an inability to fully document benefits to Stanford University from review of groundwater level data in the SCVWD ZOB study, and there were small model-predicted changes in groundwater levels in the Stanford area from District activities. Given the various factors cited above, model-predicted changes in groundwater levels are almost certainly over-estimated and not reliable as a basis for determining whether or not Stanford University is within the Zone of Benefits.

10) Non-facility recharge is not well documented in the model report. It is not clear what assumptions are used in terms of natural streambed percolation recharge that would occur without SCWVD facilities vs. the amounts attributed to being related to SCVWD facilities.

11) The discussion and summary of non-facility recharge (page 4-62 of Hydrogeologic Interpretation TM) are acknowledged as being too low, including an apparent estimate of zero recharge attributed to non-facility streams. This does not even consider how much natural recharge would occur on facility streams in the absence of District facilities (i.e., some stream recharge attributed to SCVWD facilities would likely occur naturally in the absence of SCVWD facilities).

12) Recharge from precipitation is quite low (0 – 1.5 inches) relative to total precipitation (14 to 37 inches) throughout the model domain and amounts to only about five percent of total precipitation. As with the apparent underestimation of natural stream recharge cited above in Comments 7, 10, and 11, underestimation of rainfall recharge tends to place greater importance on SCVWD recharge activities (i.e., SCVWD artificial recharge constitutes a greater than actual proportion of the total basin recharge) than likely occurs in reality for the groundwater basin.

13) The model results figures in the ZOB study (e.g., Figures 38 and 39 on pages 78 and 79) do not specify what model layer is being represented by results displayed in the figure. Model results will almost certainly vary by model layer. Appendix H of the ZOB study refers to some additional model files (e.g., GIS shapefiles related to model assumptions, output head files) that may be useful in better understanding these model results; however, these and other important model files were not included in the model files provided to us. The intent of our original model file data request was to obtain all relevant model files; however, we only received a subset of the model files utilized in the ZOB study.

14) The ZOB study did not establish a threshold of significance for a District benefit to a given area. While the minimum model-determined benefit determined in the study was stated to be 3.9 feet (and appears to occur in the Stanford area based on Figure 39 of the ZOB study), the actual benefit in the Stanford area is likely much less than 4 feet due to reasons cited above. It is not clear how the Stanford area experiences any significant benefit from groundwater level increases that are likely to be less than two feet from District-related activities.

15) The ZOB study fails to establish a proportionate range of benefits to acknowledge large benefits in some areas versus minimal to negligible benefits in other areas. It is not reasonable for pumping tax fees to be similar for areas experiencing more than 100 feet of groundwater level increase benefits versus areas experiencing less than 2 to 4 feet of groundwater level increase from District activities.
16) Inasmuch as the model appears to simulate minor benefits that are arguably unrealistic, it should be noted that the siting and construction of SCVWD facilities was based on historic cost benefit analyses in which no benefit (such as up to 4 feet of water level increase as in the model result) was allocated or even described as a project objective for northern areas including the Stanford campus. In fact, records indicate that chronic water level declines due to over pumping in the northern areas were addressed by importing water from the San Francisco regional supply system. This measure was a solution distinct from the recharge facilities now evaluated in the ZOB study.

Overall, there are four major points to summarize from our review of the ZOB study. First, the groundwater level data analysis performed for the Stanford area utilized only one short evaluation period from 2011 to 2013, and our review of a more comprehensive data set indicates stable to decreasing water levels in contrast to ZOB study conclusions. Regardless, the Stanford/Palo Alto area is so distant from the nearest SCVWD recharge facility that it would be essentially impossible to distinguish a small SCVWD benefit in local groundwater level data from the likely more prominent effects of local recharge and pumping.

Second, there are several characteristics of the SCVWD groundwater model in the Stanford area that will tend to cause the model to incorrectly predict greater groundwater level changes attributed to District recharge activities than would be expected to occur in reality. Given that the groundwater model is the primary method applied in the SCVWD ZOB study to conclude that Stanford is within the zone of benefits, modifications to the groundwater model are needed to provide valid and more reliable predictions of groundwater level changes in the Stanford area.

Third, there is a need to establish a level of significance (with sufficient justification for the selected threshold) to estimated groundwater level changes in a given area for which a true benefit is derived from District recharge activities.

Fourth, to the extent that some areas may be shown to exceed the threshold of significance for deriving benefits, there needs to be a sliding scale of pumping assessment rates such that areas receiving only minimal benefits (e.g., less than five feet of groundwater level increase) pay lower rates than areas receiving maximum benefits (e.g., over 100 feet of groundwater level increase) from District recharge activities. While this final point is a matter of fair allocation, the District's study does not provide compelling evidence of even a minimal benefit to the Stanford and Palo Alto area.

5750 Almaden Expressway, San Jose, CA 95118-3614 | (408) 265-2600 | www.valleywater.org

Santa Clara Valley
Water District

DRAFT

November 20, 2018

Mr. Tom Zigterman
Stanford University
Water Resources & Civil Infrastructure Group
327 Bonair Siding
Stanford, CA 94305-7272

Subject**:** Response to Stanford Comments on Preliminary Groundwater Benefit Zone Study Report

The Santa Clara Valley Water District (District) appreciated the opportunity to meet with you July 9, 2018 to discuss your comments on the Preliminary Groundwater Benefit Zone Study Report (Preliminary Report). Although the Preliminary Report will not be finalized until stakeholder engagement is completed, the District would like to forward Montgomery & Associates' (formerly Hydrometrics Water Resources Inc.) response to your comments and send the additional information you requested. The attached hydrographs present your wells grouped together, as well as individually, as you requested.

As we have discussed, the District continues to seek input from stakeholders on this study. If you have any additional information that you believe will inform the study conclusions and recommendations, please let us know. Thank you again for the opportunity to meet with you and discuss the study results. If you have any questions, please contact me at (408) 630-2964.

Sincerely,

George F Cook Jr

George Cook, P.G.
Senior Water Resources Specialist
Groundwater Management Unit

ecc: Cameron Tana, Montgomery & Associates
N. Hawk, G. Hall, V. De La Piedra

Attachments: Montgomery & Associates' Response
Stanford Well Hydrographs

October 26, 2018

George Cook
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614

SUBJECT: STANFORD UNIVERSITY COMMENTS ON PRELIMINARY GROUNDWATER ZONE OF BENEFIT STUDY FOR SANTA CLARA VALLEY WATER DISTRICT

Dear Mr. Cook:

Stanford University (Stanford) provided comments on the preliminary Zone of Benefit (ZOB) Study (study) which identifies areas within Santa Clara County that benefit from District activities. One of Stanford’s main comments is that the “study provides for inclusion of the Stanford area in the ZOB based primarily on groundwater model simulation results.” Groundwater model simulation results are not the primary basis for inclusion of the Stanford area in the ZOB. The primary bases for the inclusion of the Stanford area in the ZOB are the groundwater level trend evaluation and information about hydrogeologic connections. The model provides supplemental information about whether the Stanford area benefits from specific District activities to conclude which zone it should be in. We believe we can clarify the reasoning behind using the groundwater level trend evaluation to conclude that groundwater pumpers in the Stanford area benefit from District activities and the area should be included in the ZOB.

GROUNDWATER LEVEL TREND ANALYSIS FOR STANFORD WELLS

One source of confusion stems from the fact that groundwater level trends from two of Stanford’s wells are grouped into the adjacent Palo Alto area trend analysis because they are located in the City of Palo Alto’s service area. These two wells west of Sand Hill Road (Stanford wells 1 and 2 or 06S03W03L010 and 06S03W03M010, respectively) are separated from the rest of the Palo Alto area by the Stanford area, and they should therefore be grouped and evaluated with the Stanford area instead of the Palo Alto area (see attached revised hydrographs with this grouping and graphs for Stanford wells individually).

The study evaluated only time periods when groundwater levels are expected to be decreasing without the District activity and District activity is stable or increasing. Stable or increasing groundwater levels identified during these periods could then be attributed to the District activity. Including Stanford wells 1 and 2 with the Stanford area adds more data to the 2011-2013 period evaluated in the report, but also allows the 1978-1982 and 1998-2004 periods to be evaluated.

Stanford well 1 shows a stable or increasing groundwater level trend in both the 1978 to 1982 and 1998 to 2004 periods, when we expect groundwater levels to decline without the benefit of District activities. Stanford well 1 data from the 1978-1982 period show a stable trend when both District activities of managed recharge and treated water delivery are stable or increasing. Stanford wells 1 and 2 data from the 1998-2004 period shows an increasing trend when the District activity of treated water delivery is increasing. Similar trends during these periods are also observed in the Palo Alto area south of Stanford and at wells south of Palo Alto towards San Jose.

Although the groundwater level trend evaluation for the Stanford area identifies benefits from District activities, and justifies including Stanford in the ZOB, it is only able to distinguish that benefits are from the treated water delivery activities based on the 1998-2004 period when volumes of managed aquifer recharge are declining. The 1978-1982 and 2011-2013 periods are overlapping periods when both District activities are stable or increasing, so benefits from managed aquifer recharge cannot be distinguished from treated water delivery benefits (see preliminary study report section 6.2.4). The model is used to evaluate effects from the District activities separately and concludes that the simulated benefits from the activities are similar. Therefore, Stanford area is included in Zone A for benefits from both activities.

HYDROGEOLOGICAL CONNECTION WITH DISTRICT ACTIVITIES

Even with this clarification, we acknowledge that there are limitations in the data from, and modeling of, the Stanford area used in the study. However, as the report states in its summary of the methodology (Section 1.2, page 3):"If data and modeling are insufficient to assess whether an area benefits from District activities, the following assumptions are made: …benefits from a District activity extend to all areas that are connected by groundwater flow (hydrogeologically connected) to the activity.”

The study report should also be revised to document that the Stanford area is hydrogeologically connected to the report’s Zone A: defined as the Unconsolidated Alluvium of the Santa Clara Plain. Evidence of the hydrogeological connection include:

- Unconsolidated alluvium is continuously mapped to include the Stanford area
- The 2015 USGS report (Wentworth et al., 2015) identifies continuous sedimentary stratigraphy from San Jose to the Palo Alto area

- Contour maps of groundwater level data including data from the Stanford area show continuous groundwater flow from areas of District activities north to Palo Alto.

The Stanford comments point to DWR's 1967 Bulletin 118, identifying the Stanford area as part of San Francisquito Cone, as evidence of a lack of hydrogeologic connection to the rest of proposed Zone A to the south. It does not, however, provide sufficient evidence to override more recent evaluations.

- While the San Francisquito Cone is identified as a physiographic feature of the Valley, this does not imply that the San Francisquito Cone is hydrogeologically separate. Other identified physiographic features are hydrogeologically connected with each other.

- The map of alluvial thickness (Plate 3) show thickness increasing to the south of San Francisquito Cone without obvious discontinuities.

- A pumping test at the Hale Street well showed drawdown to the south, toward what is defined as the San Francisquito Cone/San Jose Plain boundary. Bulletin 118 evaluates the pumping test to demonstrate little movement between the Niles Cone and San Franciquito Cone but does not conclude something similar between San Francisquito Cone and San Jose Plain to the south.

- Different hydraulic characteristics that may occur in the San Francisquito Cone do not preclude a hydrogeologic connection.

CONCEPT OF PROPORTIONAL BENEFIT

The Stanford comments also state that District pumping charges should be proportional to the magnitude of benefits. This issue has already been addressed in response to a similar comment made by Stanford on a memo describing the study methodology:

> Our research and interpretation of groundwater benefit zones established by other California agencies does not present examples of a "relative weighting" concept as described by the commenter. The relative benefit is likely to continuously change with distance from District activities, so defining zones based on a specified level of benefit would be arbitrary. The methodology includes evaluation of different types of benefits in order to assess the extent of benefit to the water budget from specific District activities. However, the different types of benefit will not be used to assess or weigh relative benefit. The zones will be drawn based on District activity that is improving the water budget of the shared resource for the area and on the premise that all groundwater users in the associated area should pay an equal share for the activity.

REFERENCES

Wentworth, C.M., R.C. Jachens, R.A. Williams, J.C. Tinsley, and R.T. Hanson, 2015, *Physical Subdivision and Description of the Water-Bearing Sediments of the Santa Clara Valley, California*, U.S. Geological Survey Scientific Investigations Report 2015-5017, April 6.

Sincerely,
MONTGOMERY & ASSOCIATES

Cameron Tana

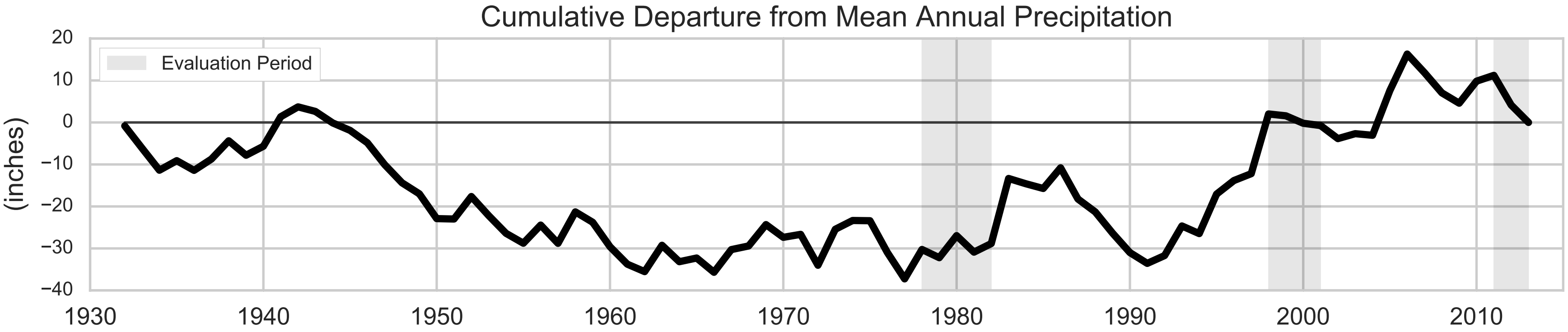
Cameron Tana, P.E.
Principal Hydrologist

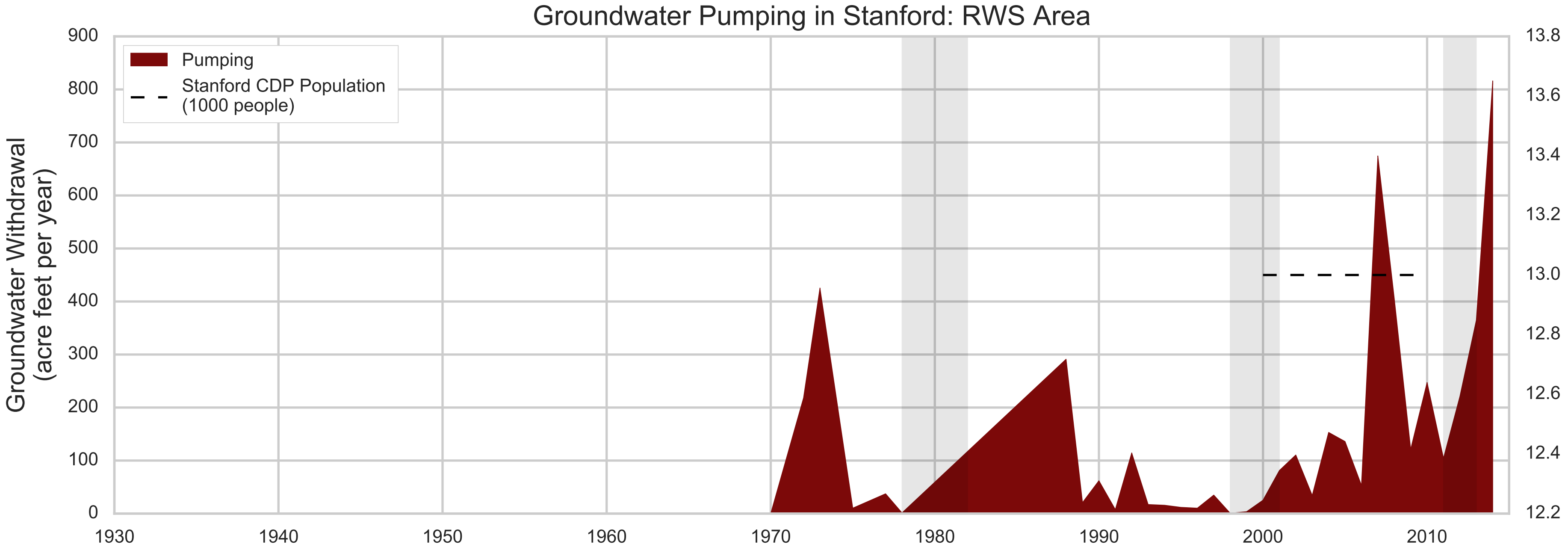
Derrik Williams

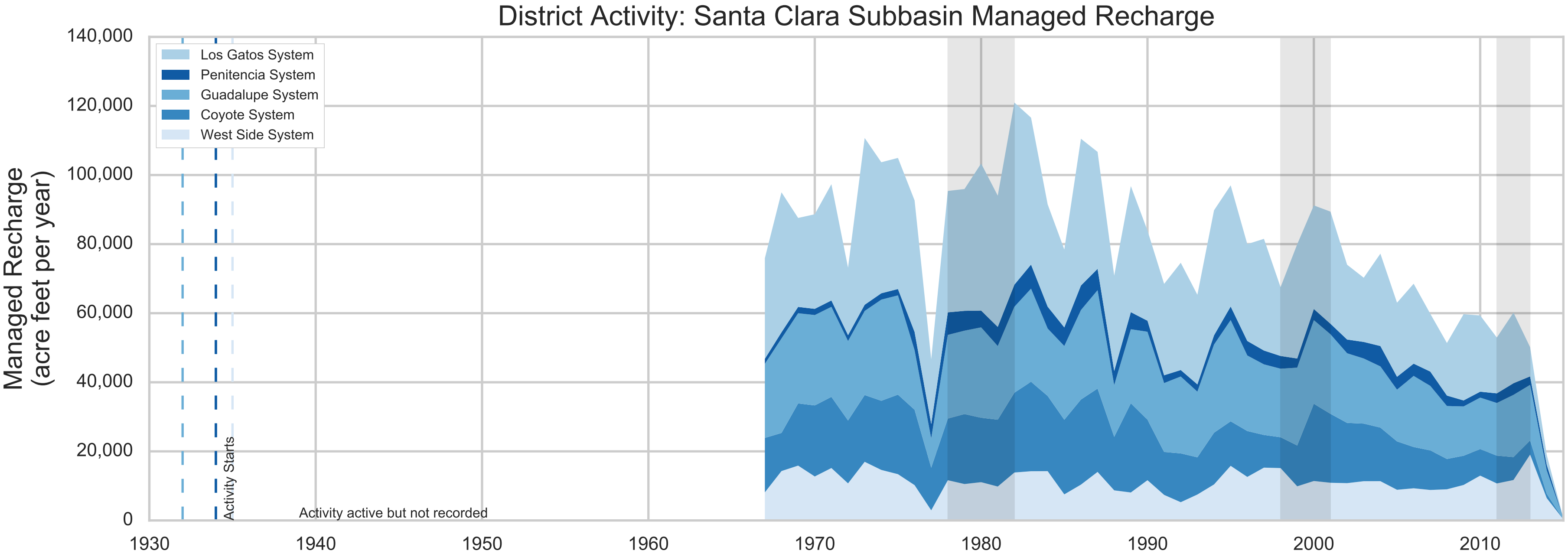
Derrik Williams. P.G., C. Hg.
Principal Hydrogeologist

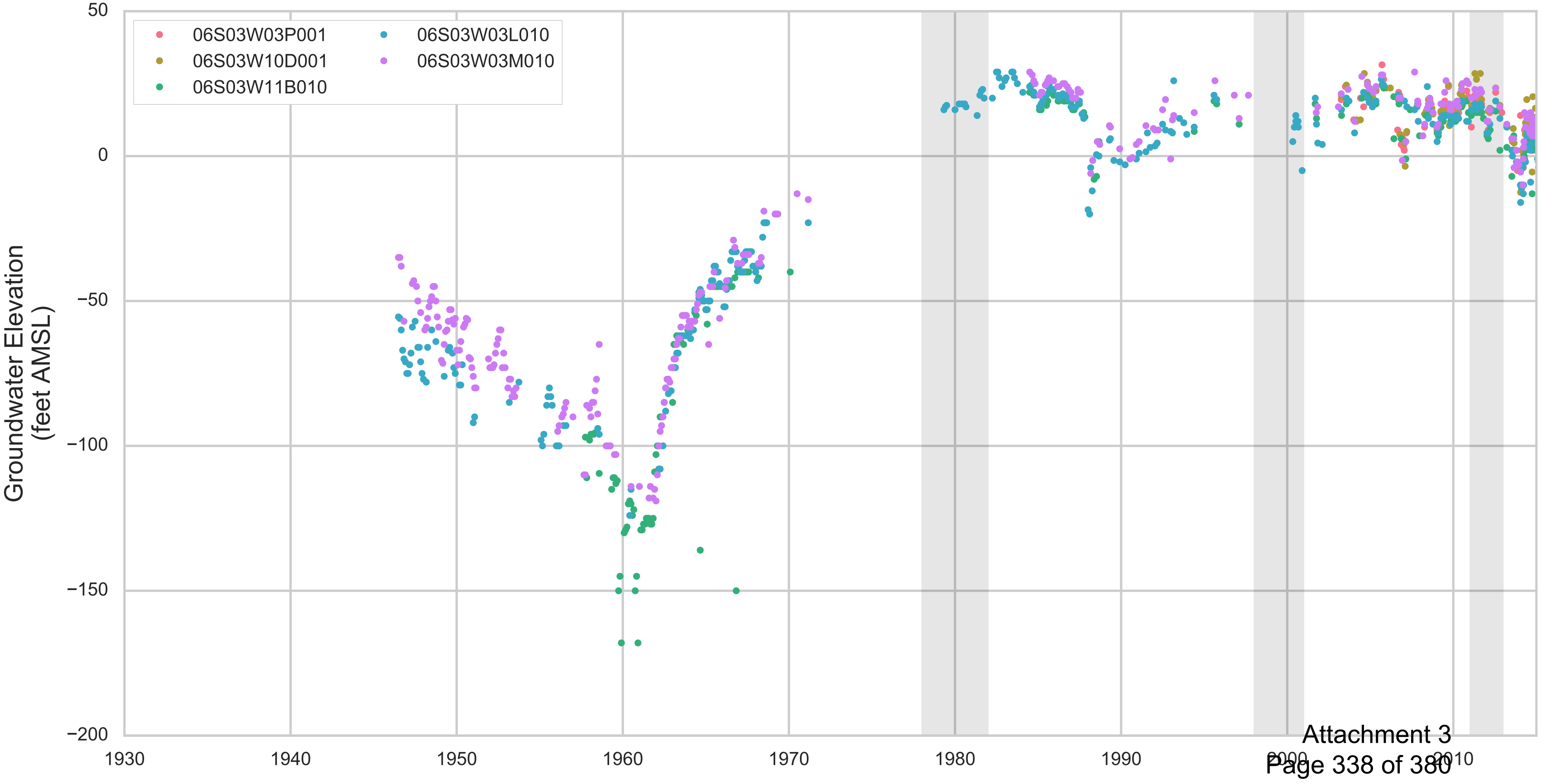
DRAFT

Pumping Area: Stanford: RWS
Activity: Santa Clara Subbasin Managed Recharge
Groundwater Level Data from: Monitored Pumping Wells


Cumulative Departure from Mean Annual Precipitation


Groundwater Pumping in Stanford: RWS Area

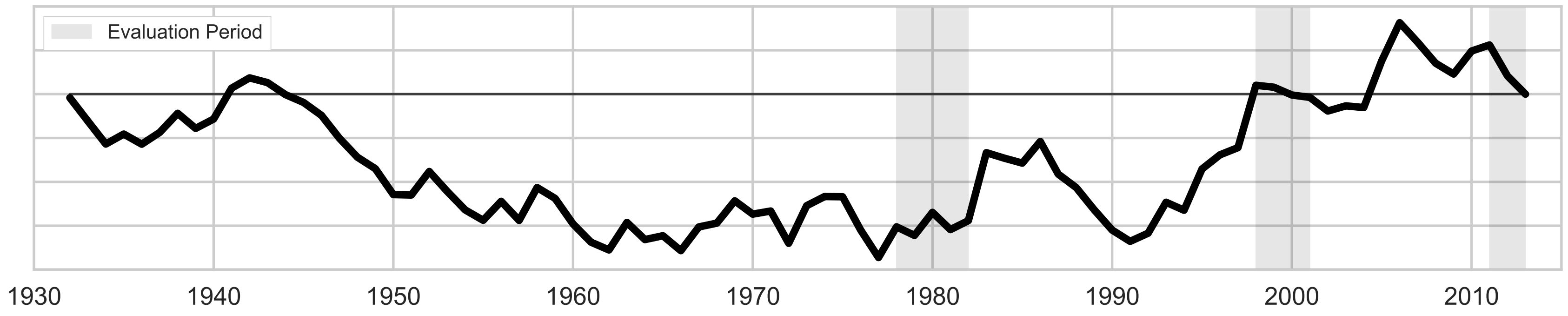

District Activity: Santa Clara Subbasin Managed Recharge


Observed Groundwater Elevations in Stanford: RWS Area

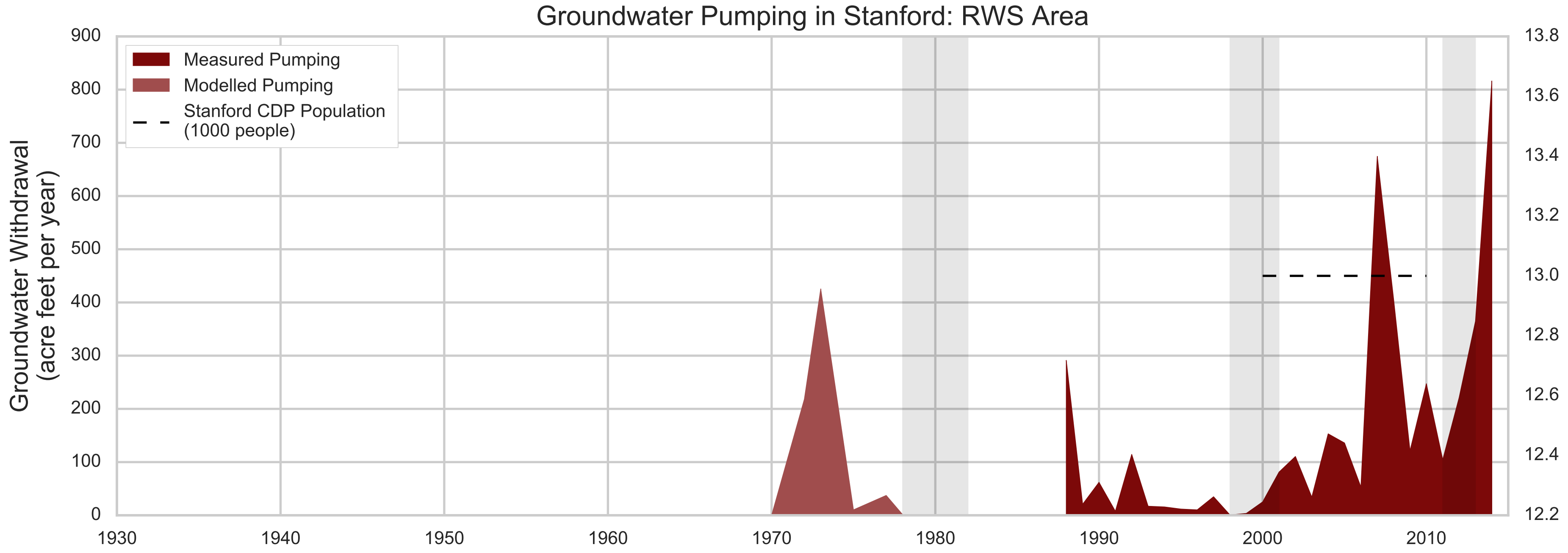
DRAFT

Monitored Pumping Wells well: 06S03W03P001
Minimum distance from activity: 32986 feet

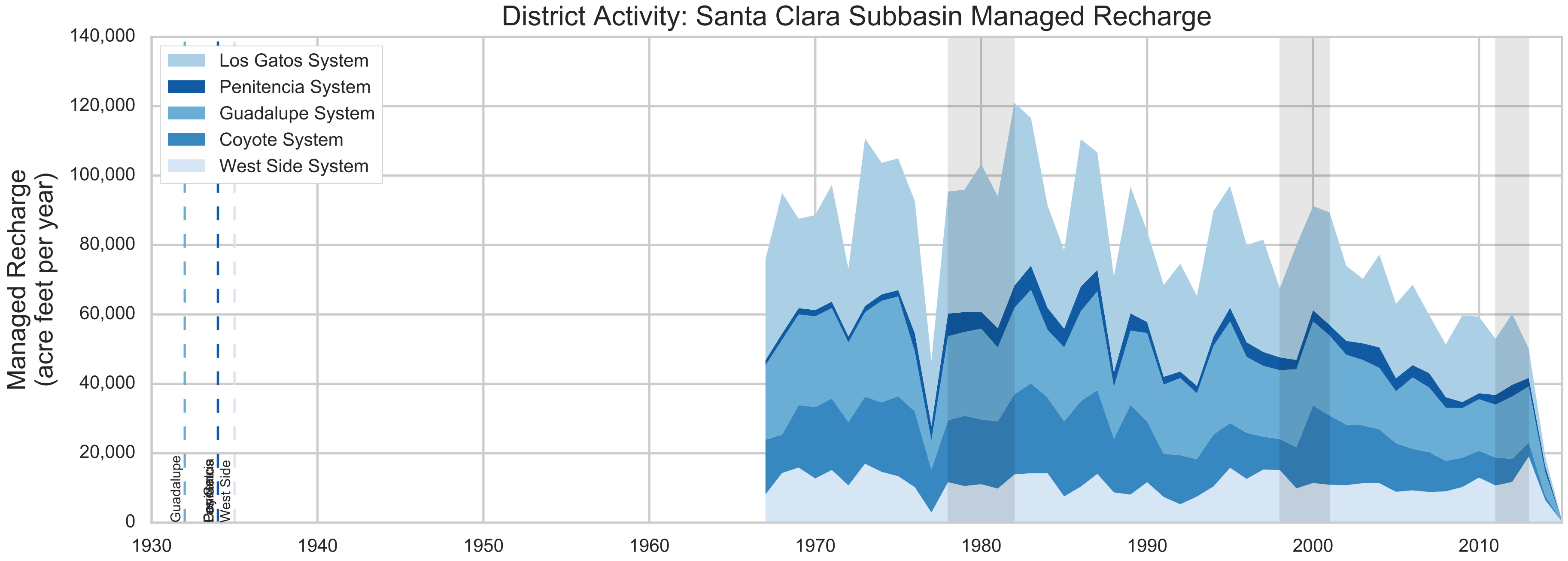
Cumulative Departure from Mean Annual Precipitation



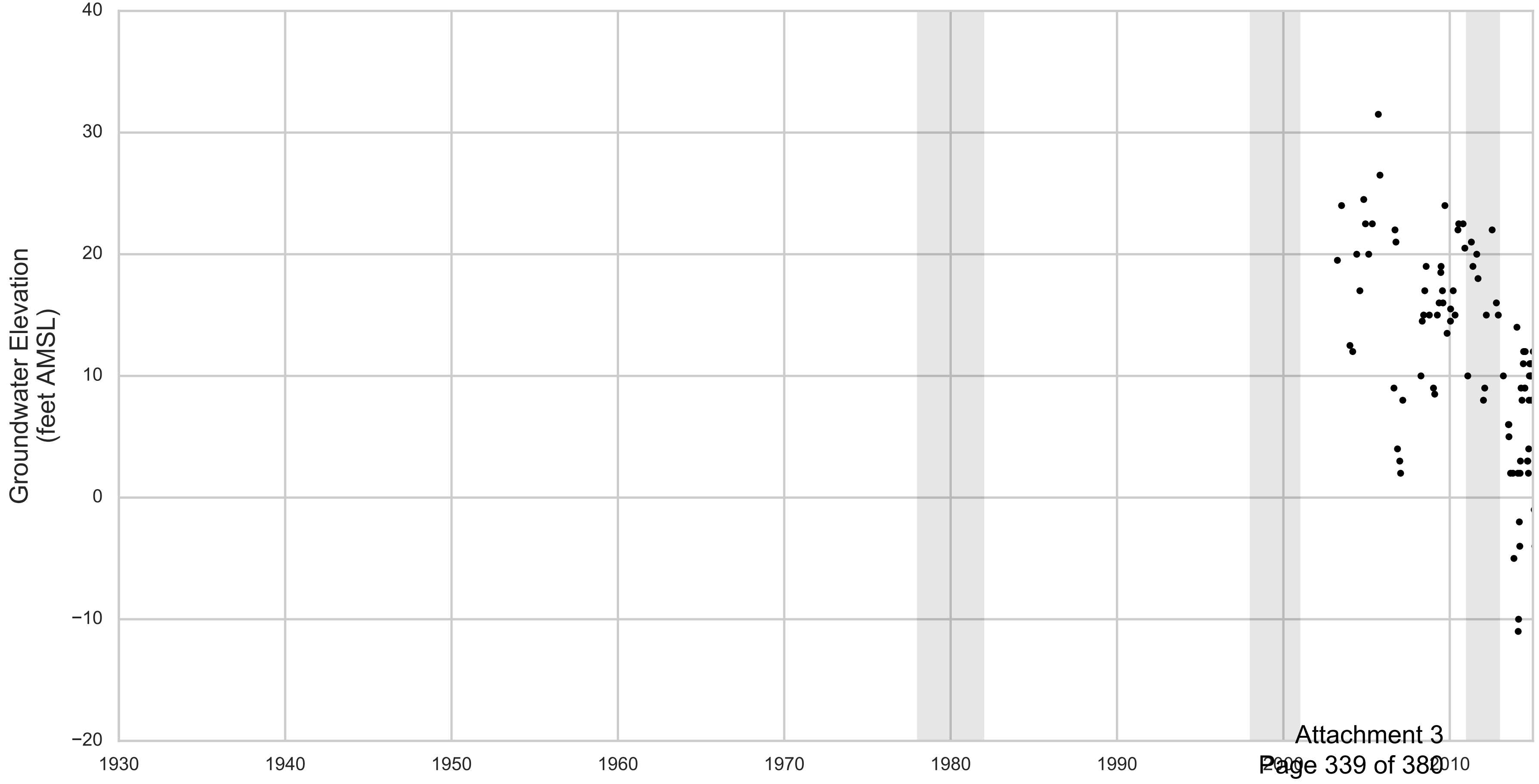
Groundwater Pumping in Stanford: RWS Area



District Activity: Santa Clara Subbasin Managed Recharge



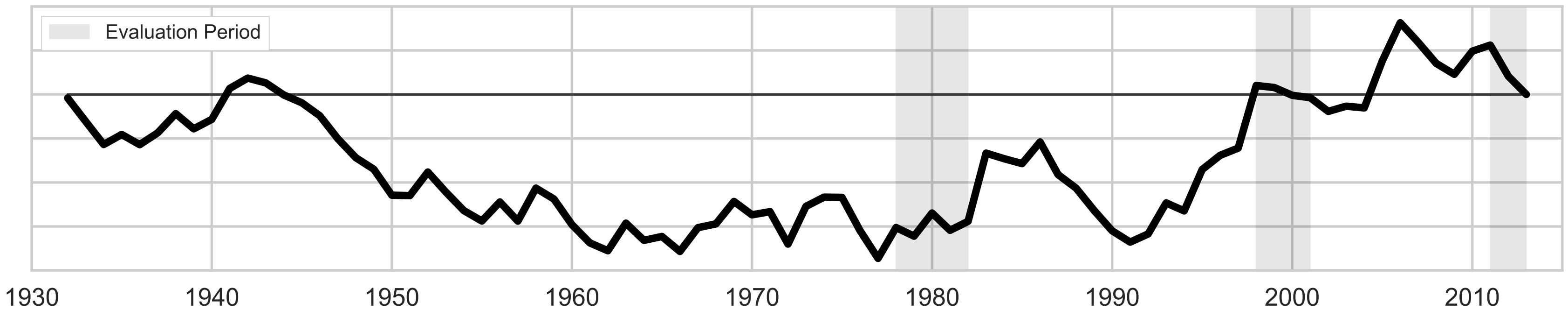
Observed Groundwater Elevation: 06S03W03P001



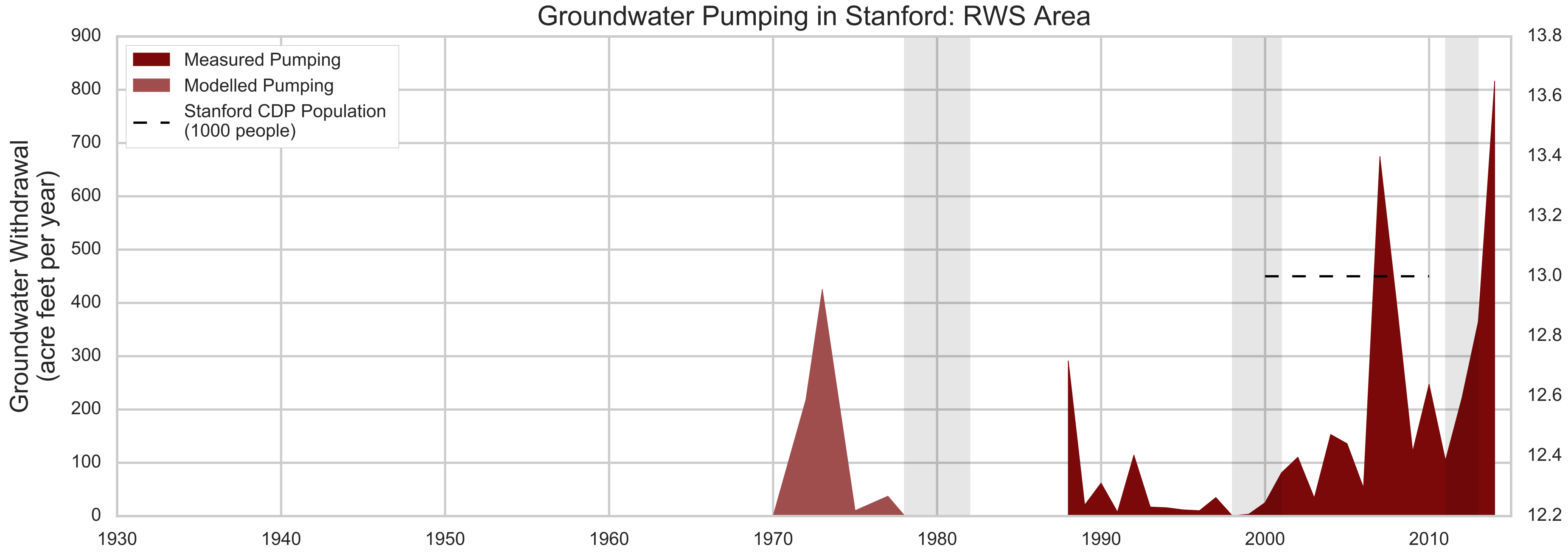
DRAFT

Monitored Pumping Wells well: 06S03W10D001
Minimum distance from activity: 33663 feet

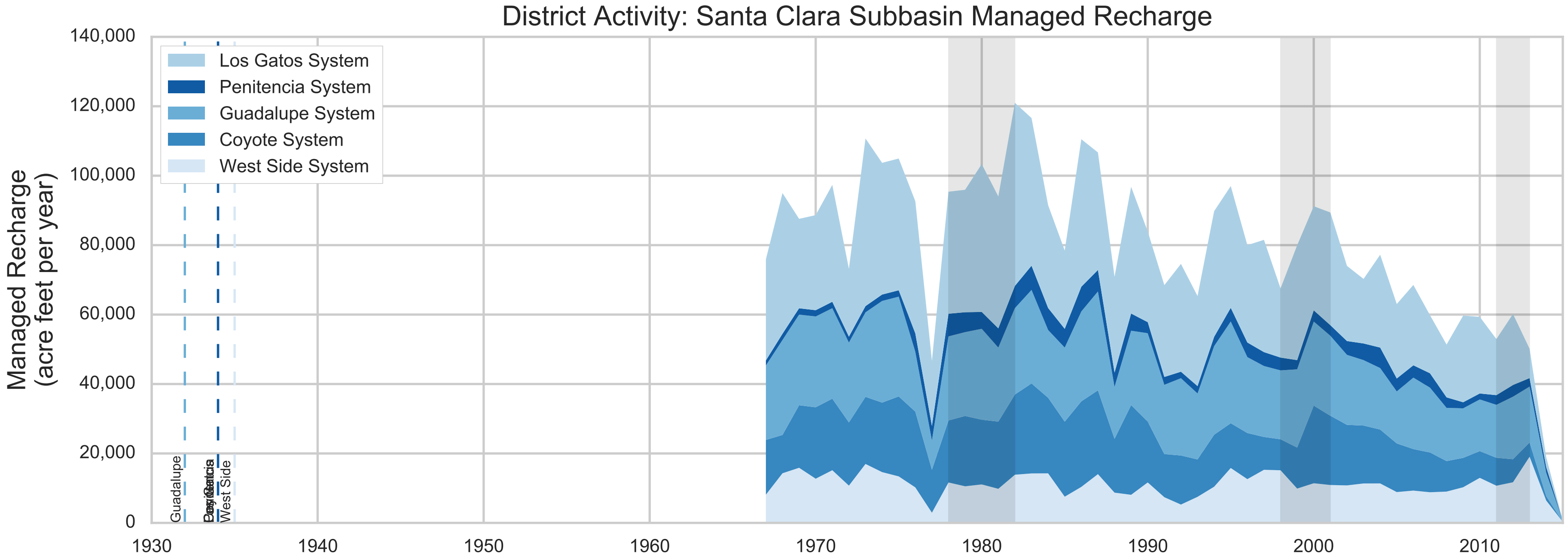
Cumulative Departure from Mean Annual Precipitation



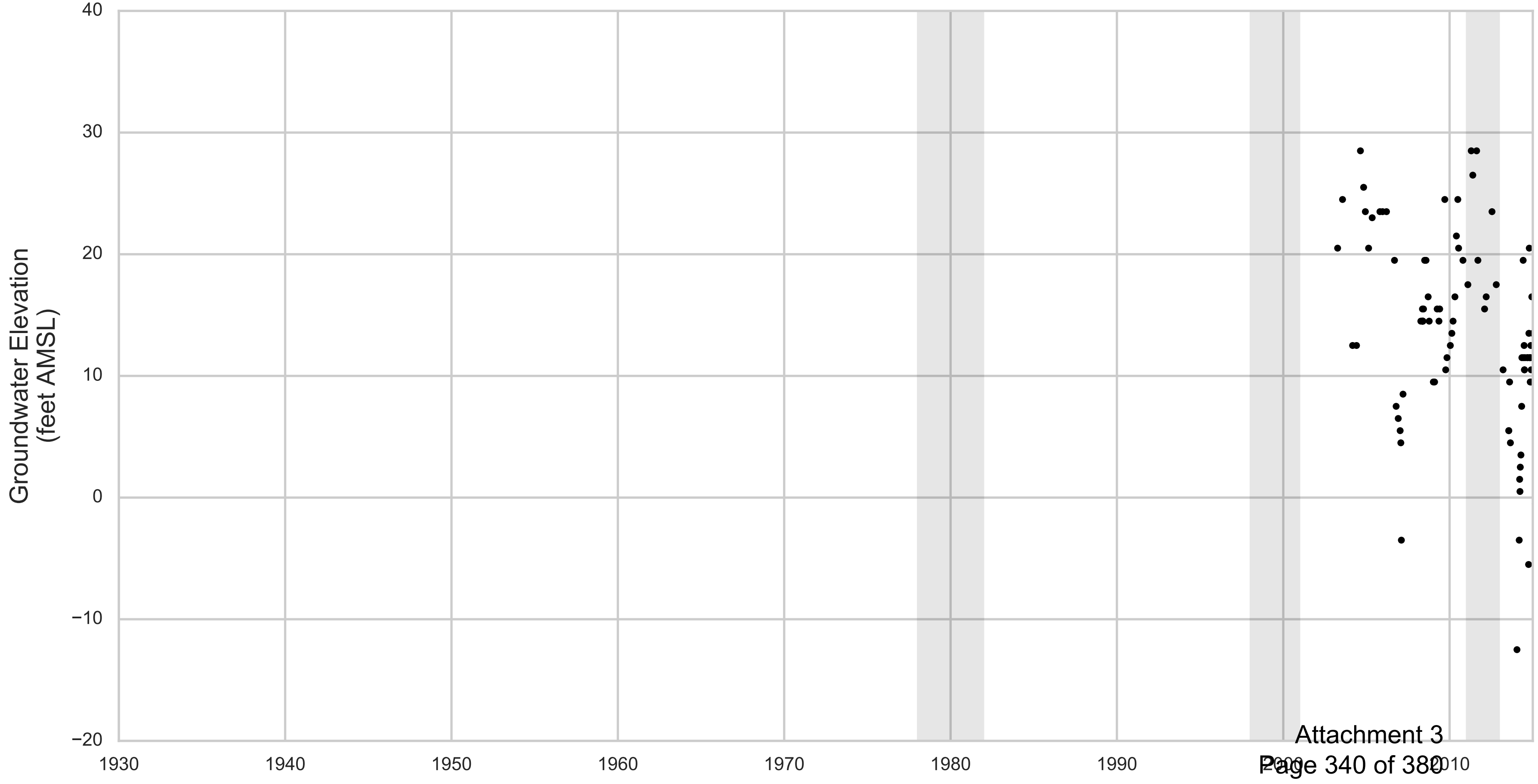
Groundwater Pumping in Stanford: RWS Area



District Activity: Santa Clara Subbasin Managed Recharge



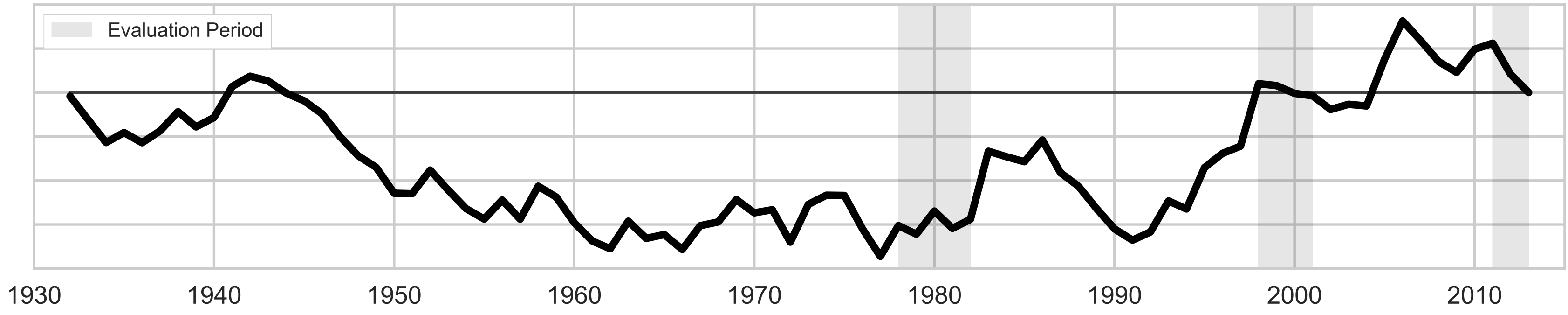
Observed Groundwater Elevation: 06S03W10D001



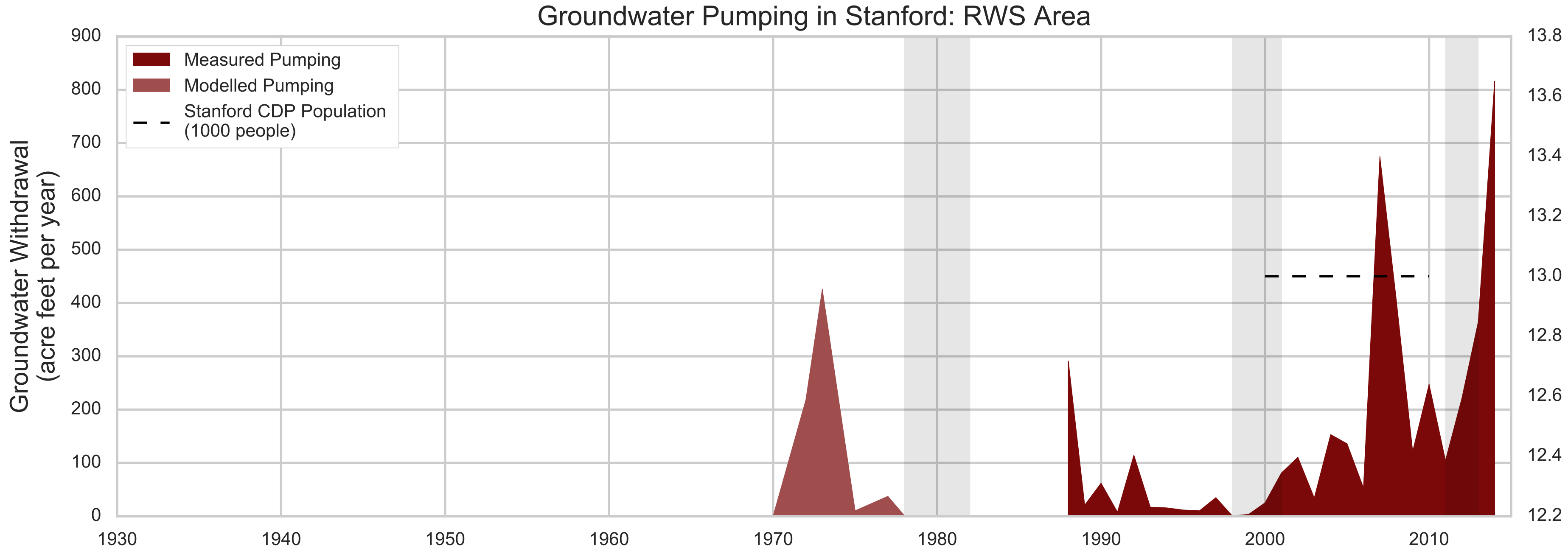
DRAFT

Monitored Pumping Wells well: 06S03W11B010
Minimum distance from activity: 25347 feet

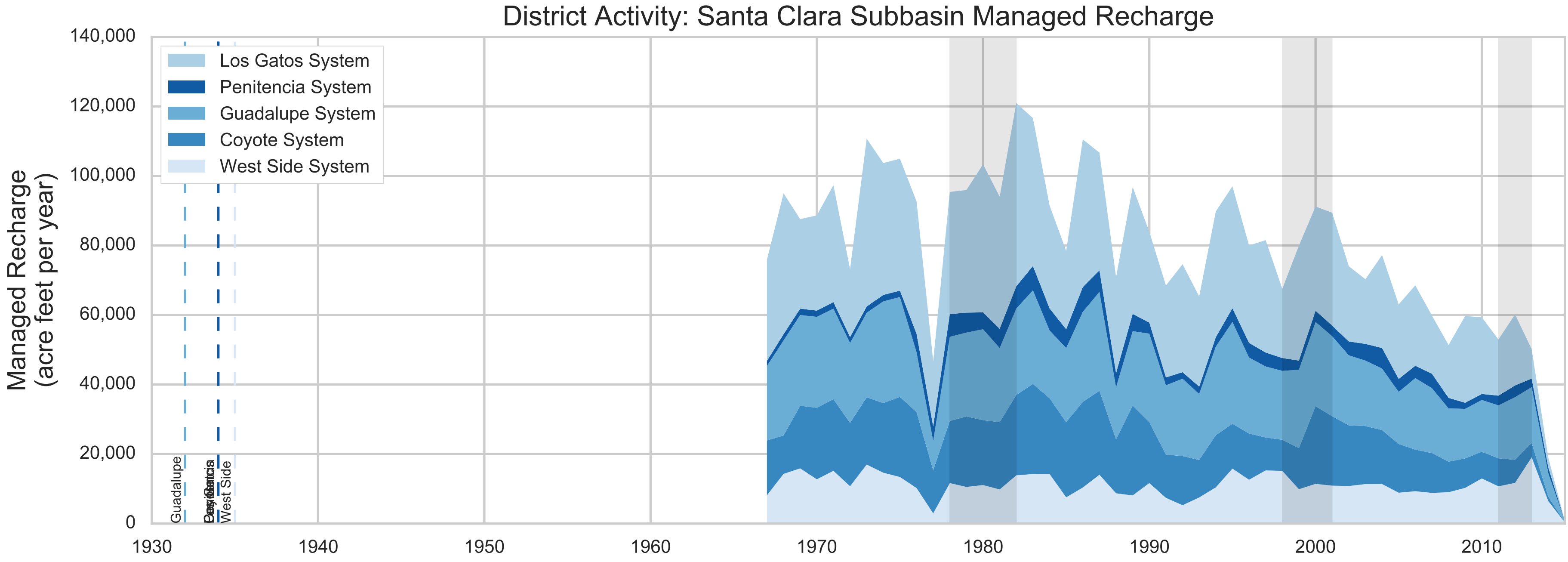
Cumulative Departure from Mean Annual Precipitation



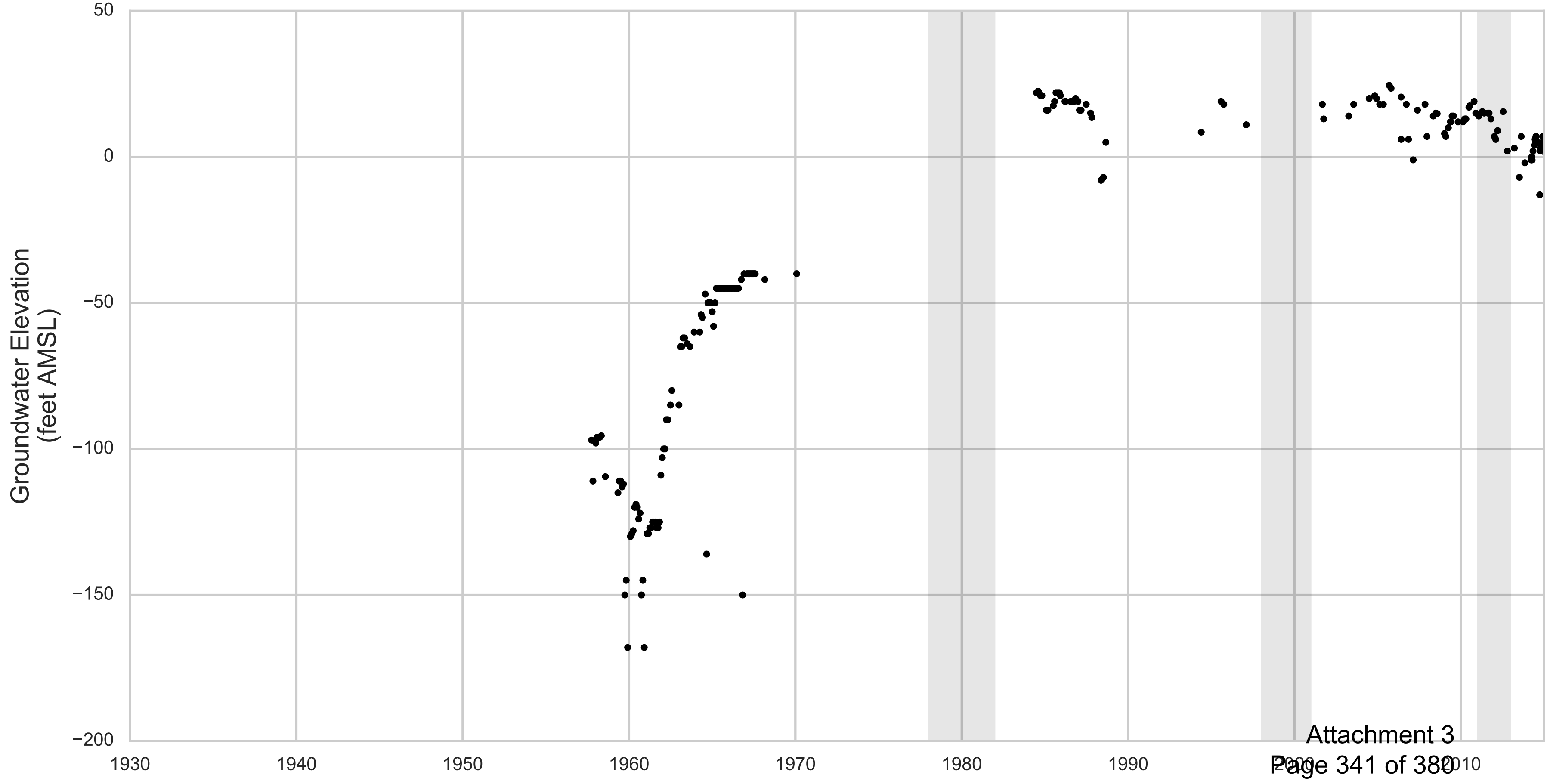
Groundwater Pumping in Stanford: RWS Area



District Activity: Santa Clara Subbasin Managed Recharge

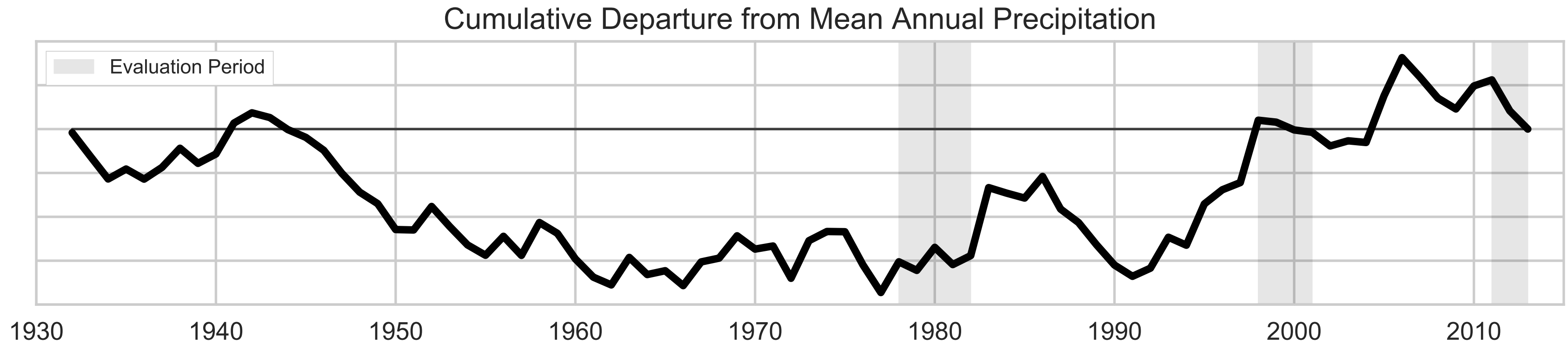


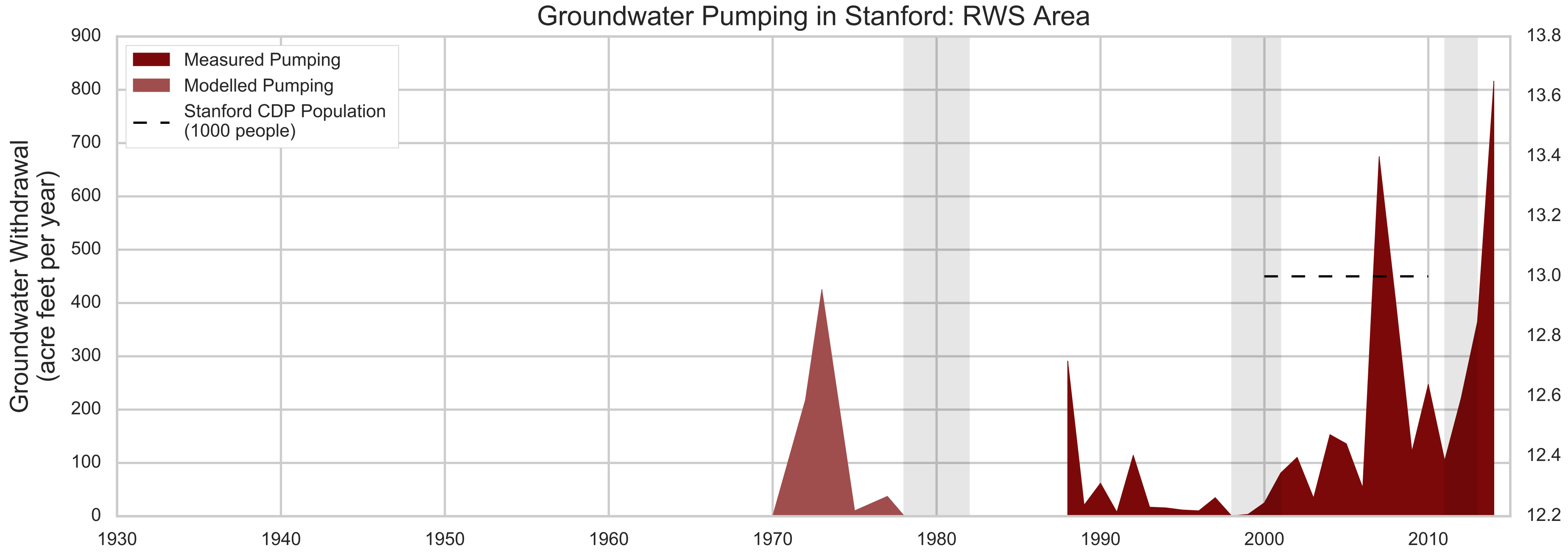
Observed Groundwater Elevation: 06S03W11B010

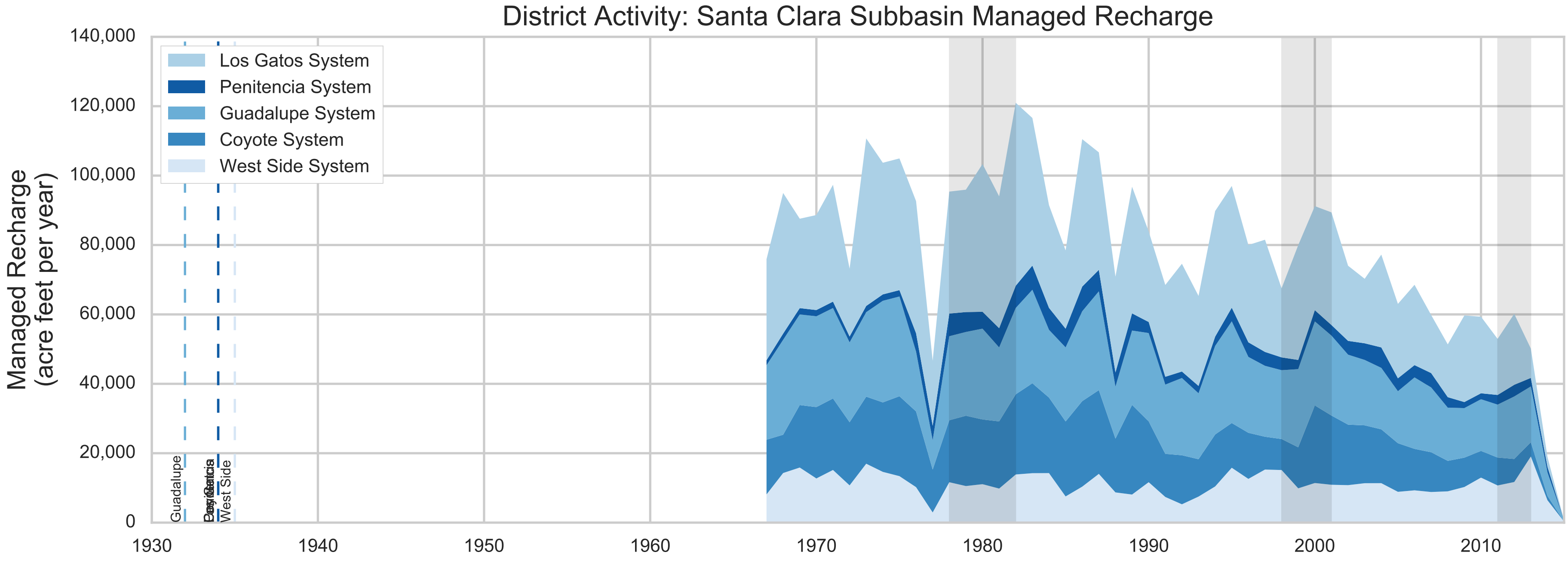


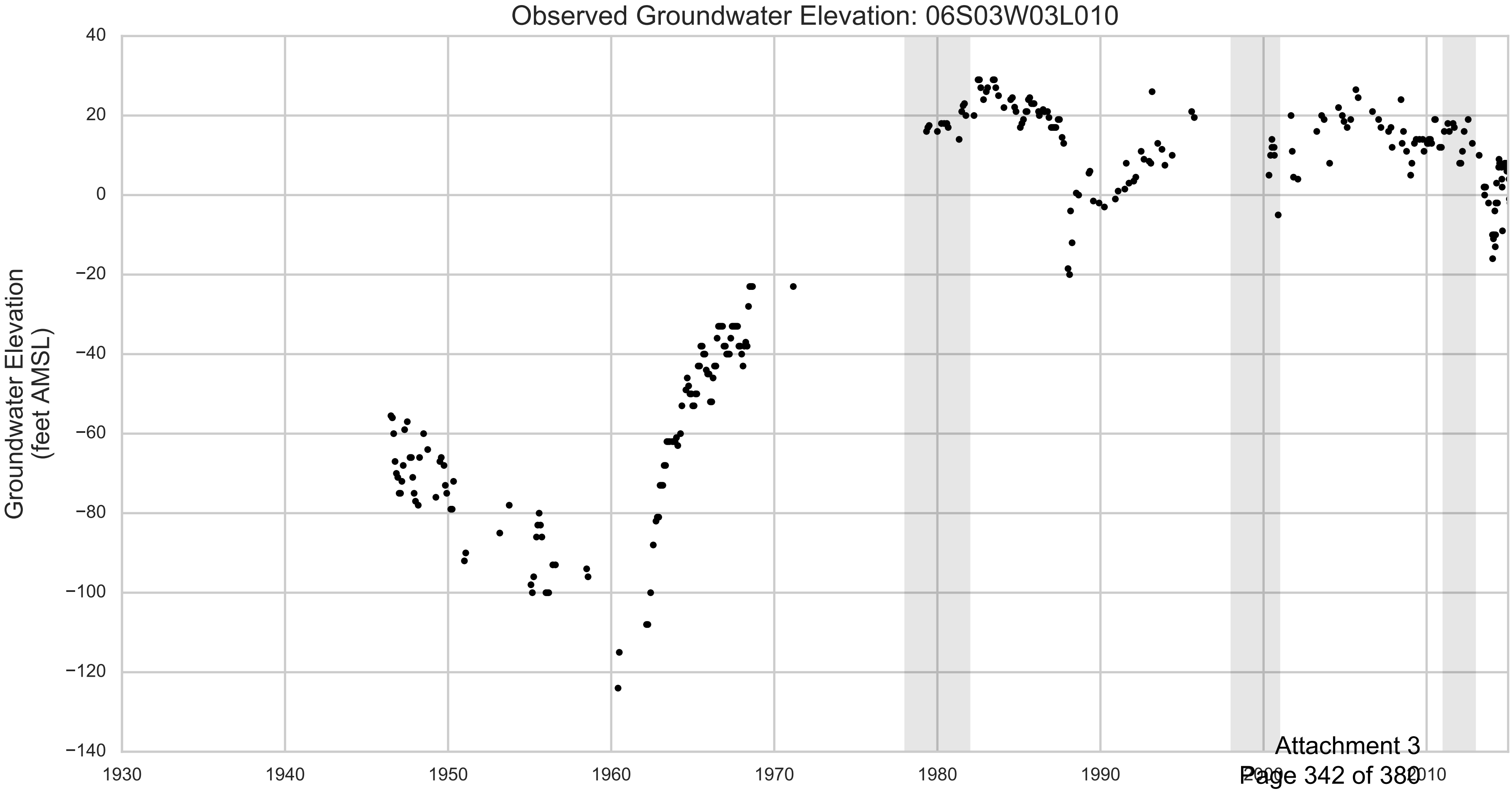
DRAFT

Monitored Pumping Wells well: 06S03W03L010
Minimum distance from activity: 31805 feet


Cumulative Departure from Mean Annual Precipitation


Groundwater Pumping in Stanford: RWS Area


District Activity: Santa Clara Subbasin Managed Recharge


Observed Groundwater Elevation: 06S03W03L010

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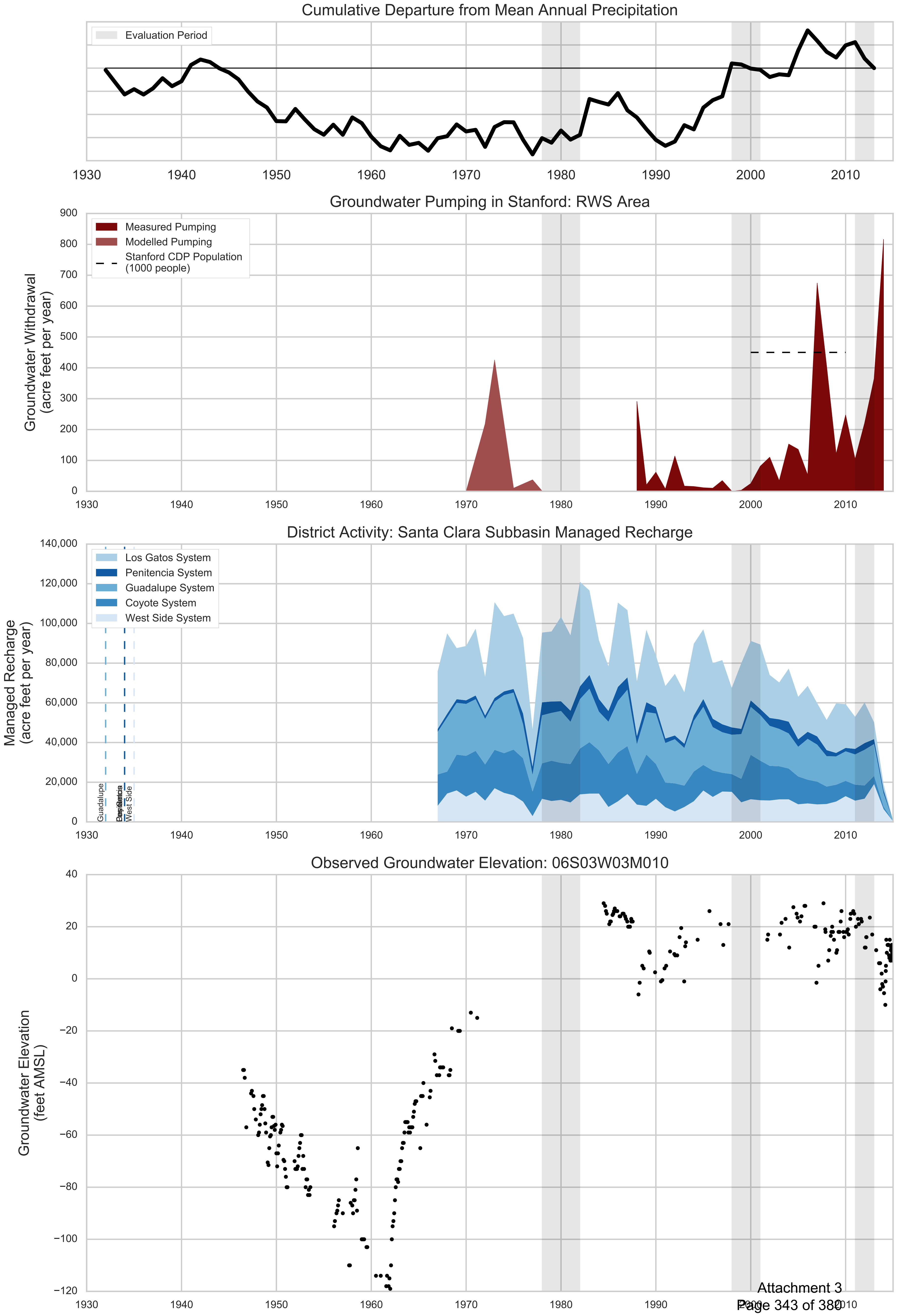
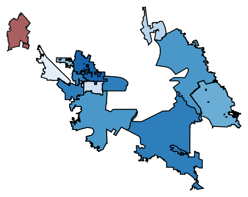
Monitored Pumping Wells well: 06S03W03M010
Minimum distance from activity: 32992 feet

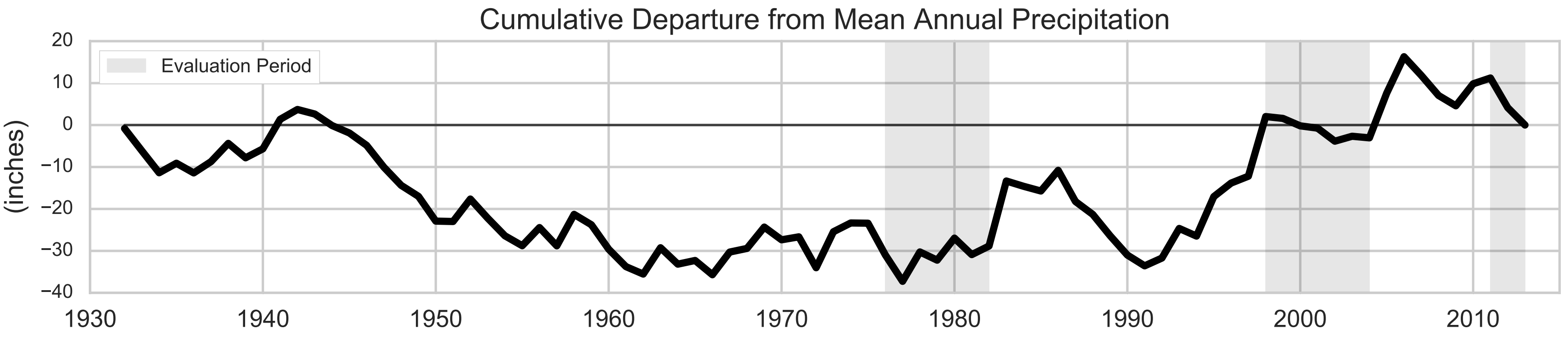

Cumulative Departure from Mean Annual Precipitation
Evaluation Period
1930
1940
1950
1960
1970
1980
1990
2000
2010
Groundwater Pumping in Stanford: RWS Area
Measured Pumping
Modelled Pumping
Stanford CDP Population (1000 people)
Groundwater Withdrawal (acre feet per year)
0
100
200
300
400
500
600
700
800
900
12.2
12.4
12.6
12.8
13.0
13.2
13.4
13.6
13.8
District Activity: Santa Clara Subbasin Managed Recharge
Los Gatos System
Penitencia System
Guadalupe System
Coyote System
West Side System
Managed Recharge (acre feet per year)
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
Guadalupe
Penitencia
West Side
Observed Groundwater Elevation: 06S03W03M010
Groundwater Elevation (feet AMSL)
40
20
0
−20
−40
−60
−80
−100
−120

DRAFT

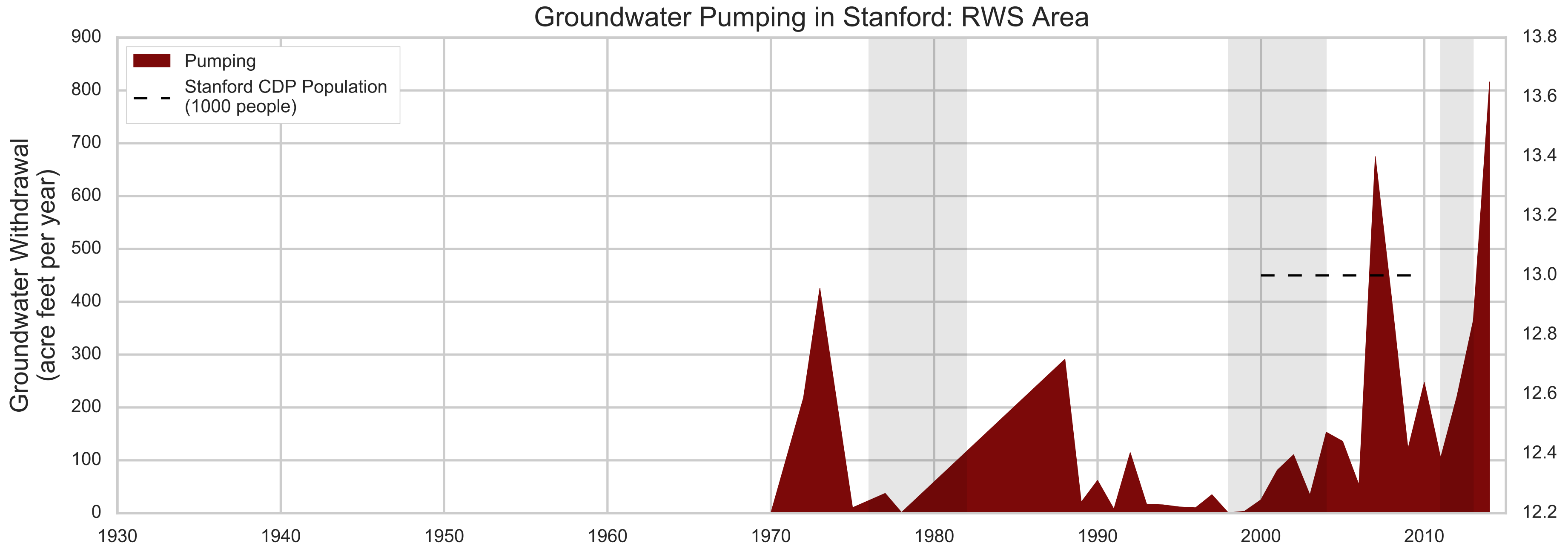
Pumping Area: Stanford: RWS
Activity: Treated Water Delivery
Groundwater Level Data from: Monitored Pumping Wells



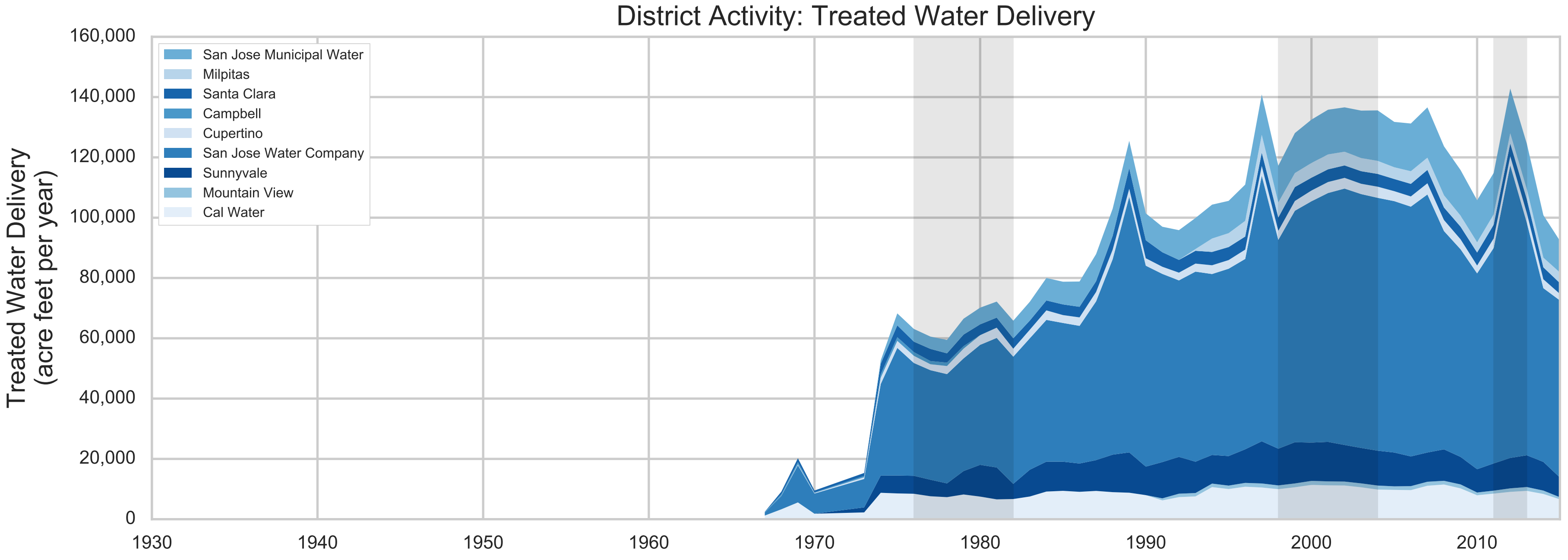
Cumulative Departure from Mean Annual Precipitation



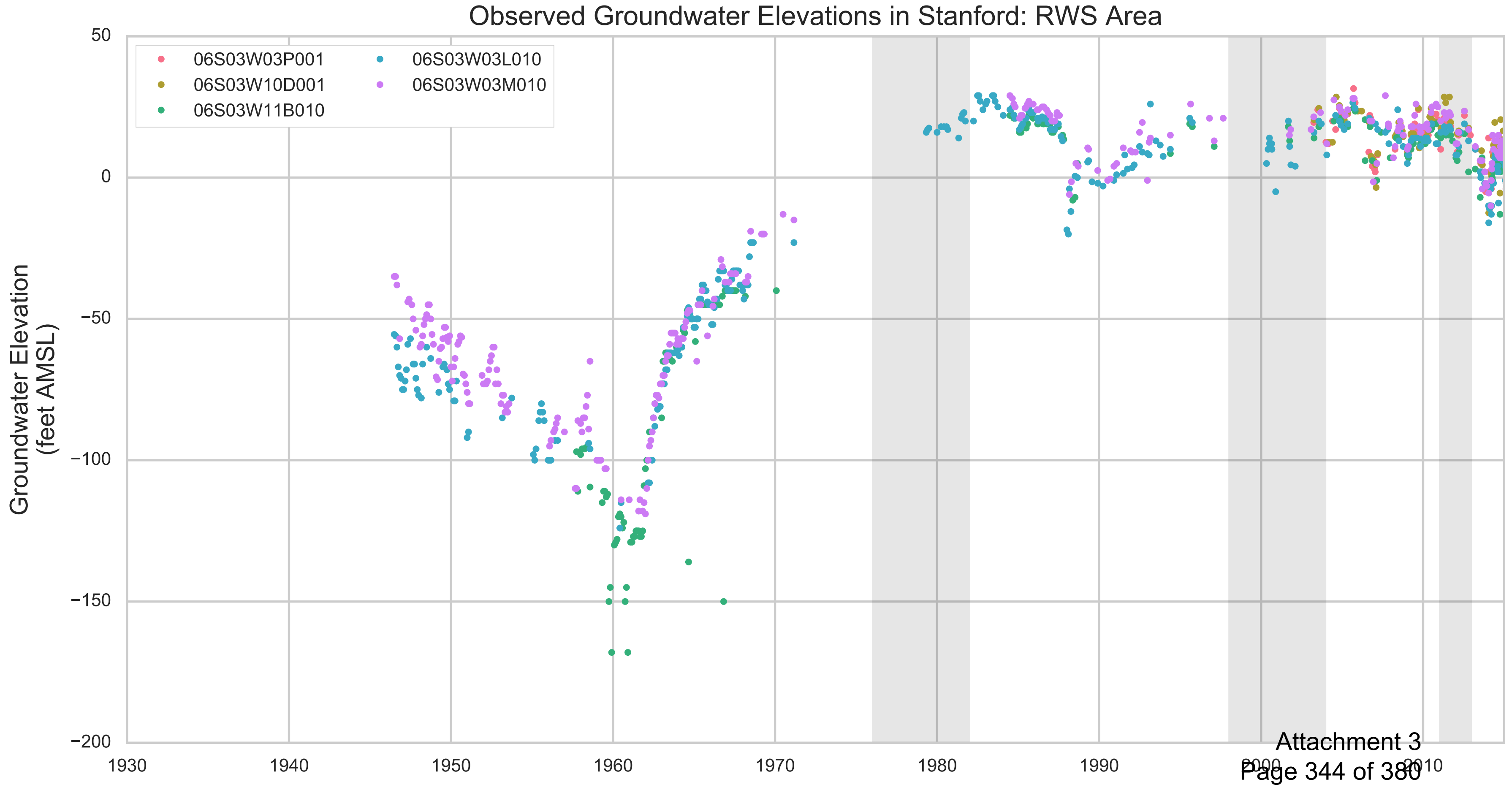
Groundwater Pumping in Stanford: RWS Area



District Activity: Treated Water Delivery



Observed Groundwater Elevations in Stanford: RWS Area



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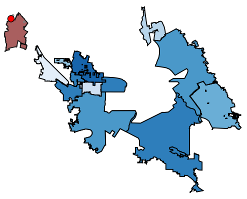
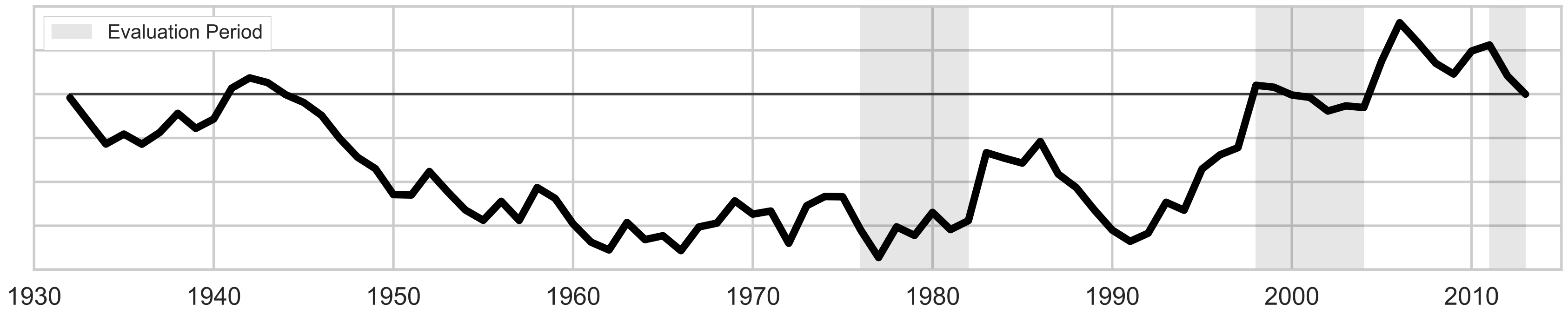
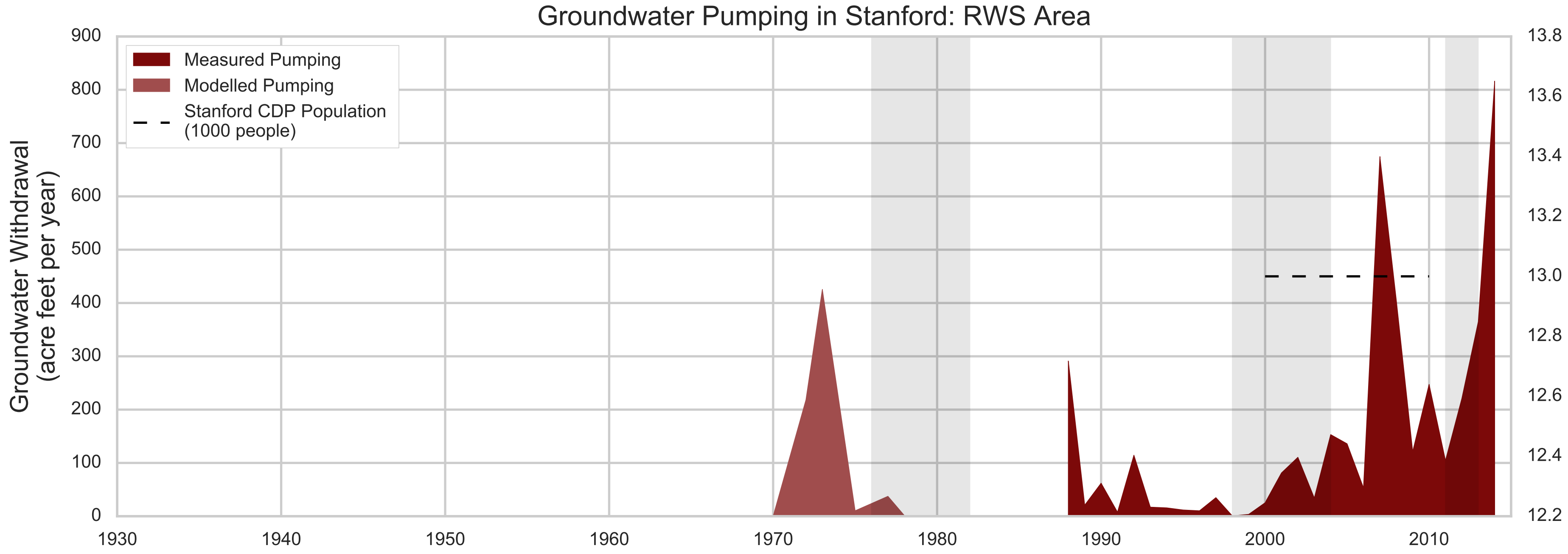


Monitored Pumping Wells well: 06S03W03P001
Minimum distance from activity: 21139 feet

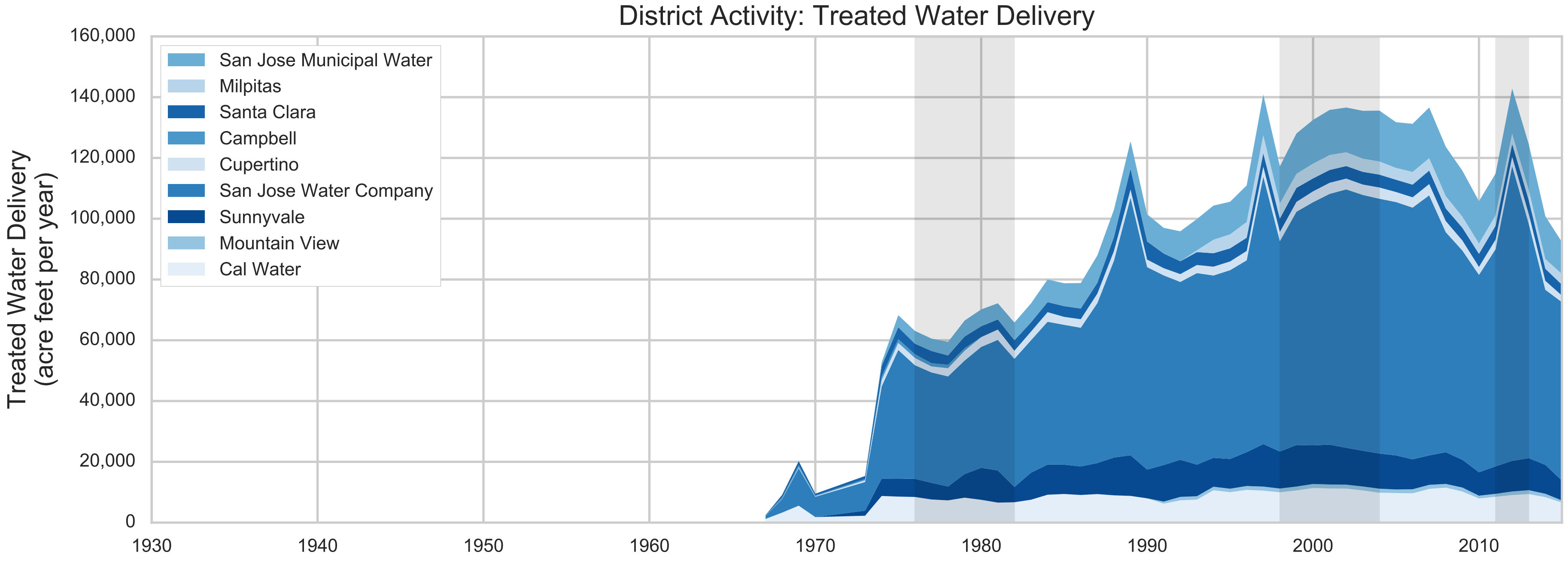
Cumulative Departure from Mean Annual Precipitation



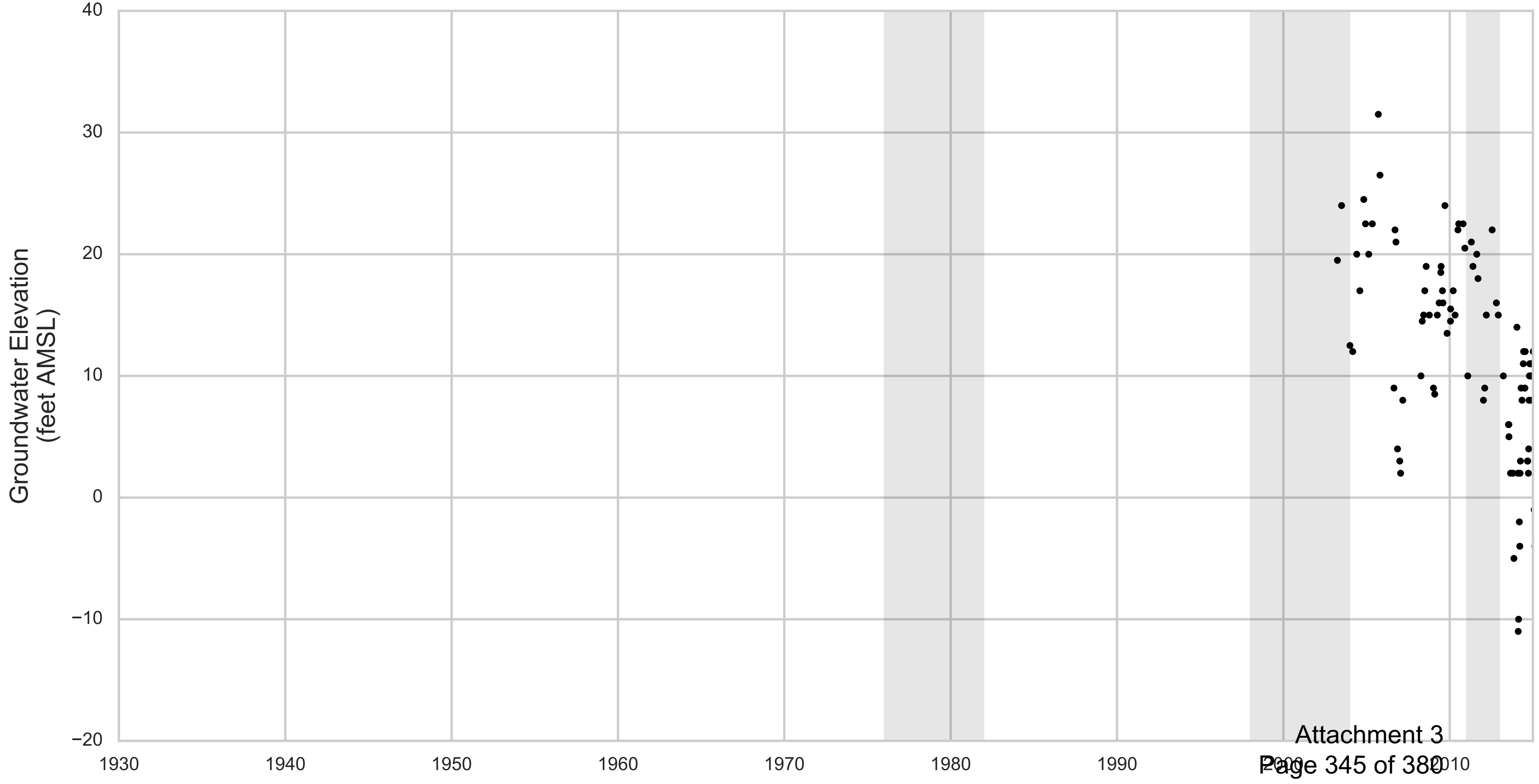
Groundwater Pumping in Stanford: RWS Area



District Activity: Treated Water Delivery

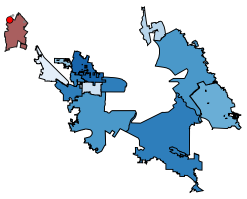


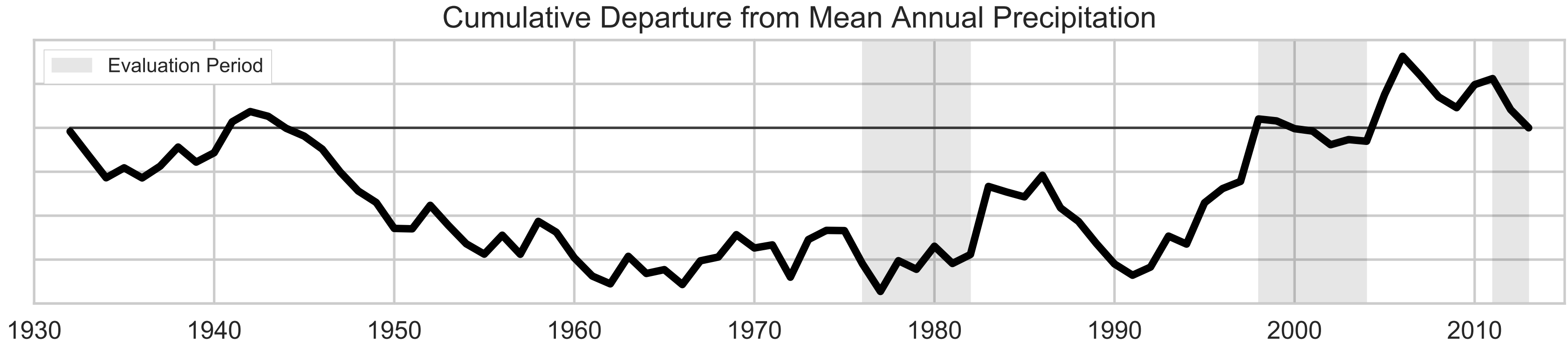
Observed Groundwater Elevation: 06S03W03P001

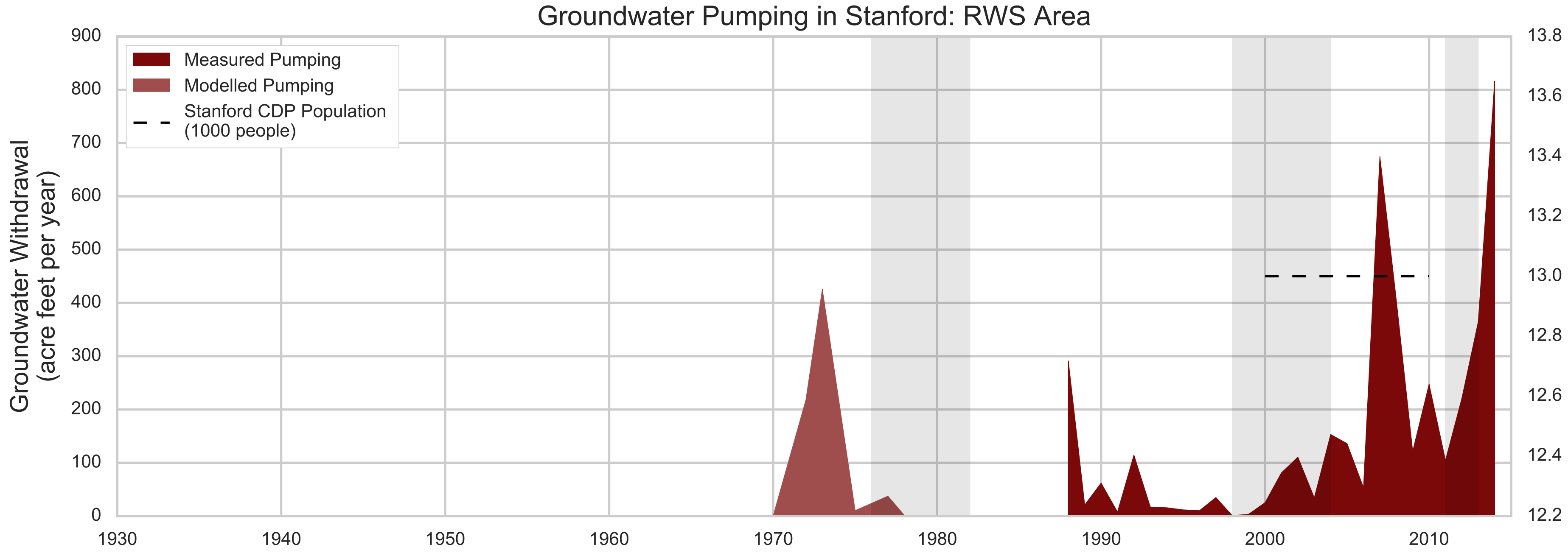


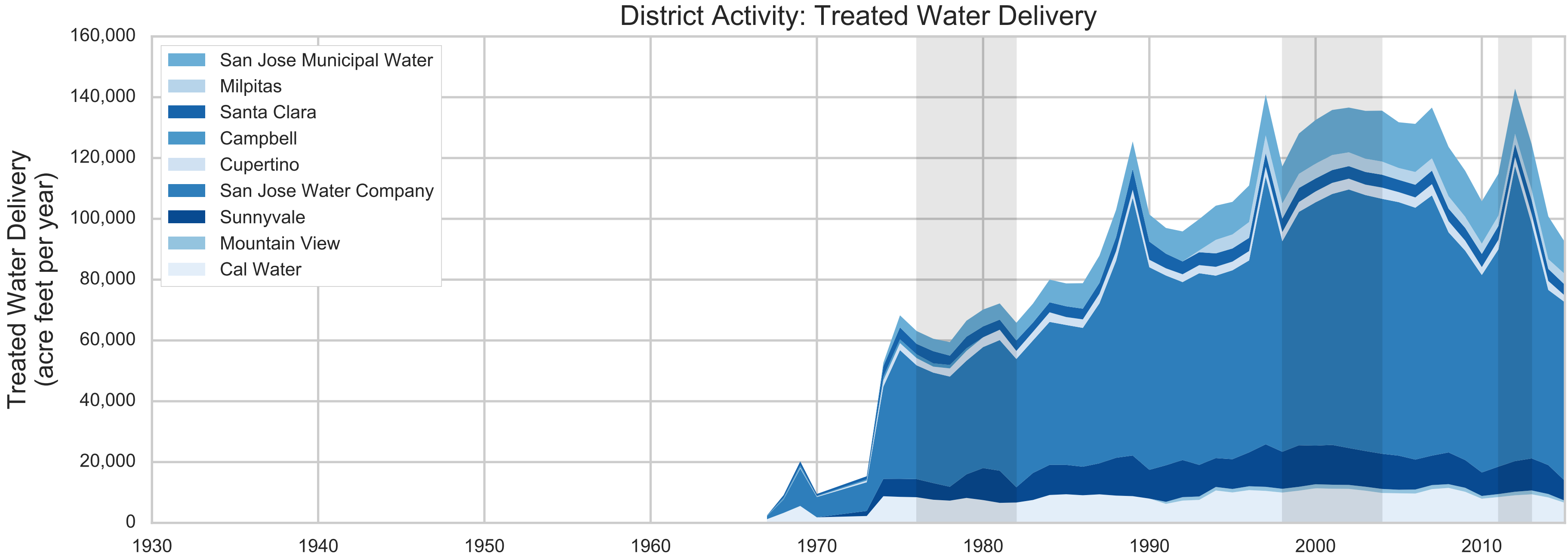
Monitored Pumping Wells well: 06S03W10D001
Minimum distance from activity: 21181 feet

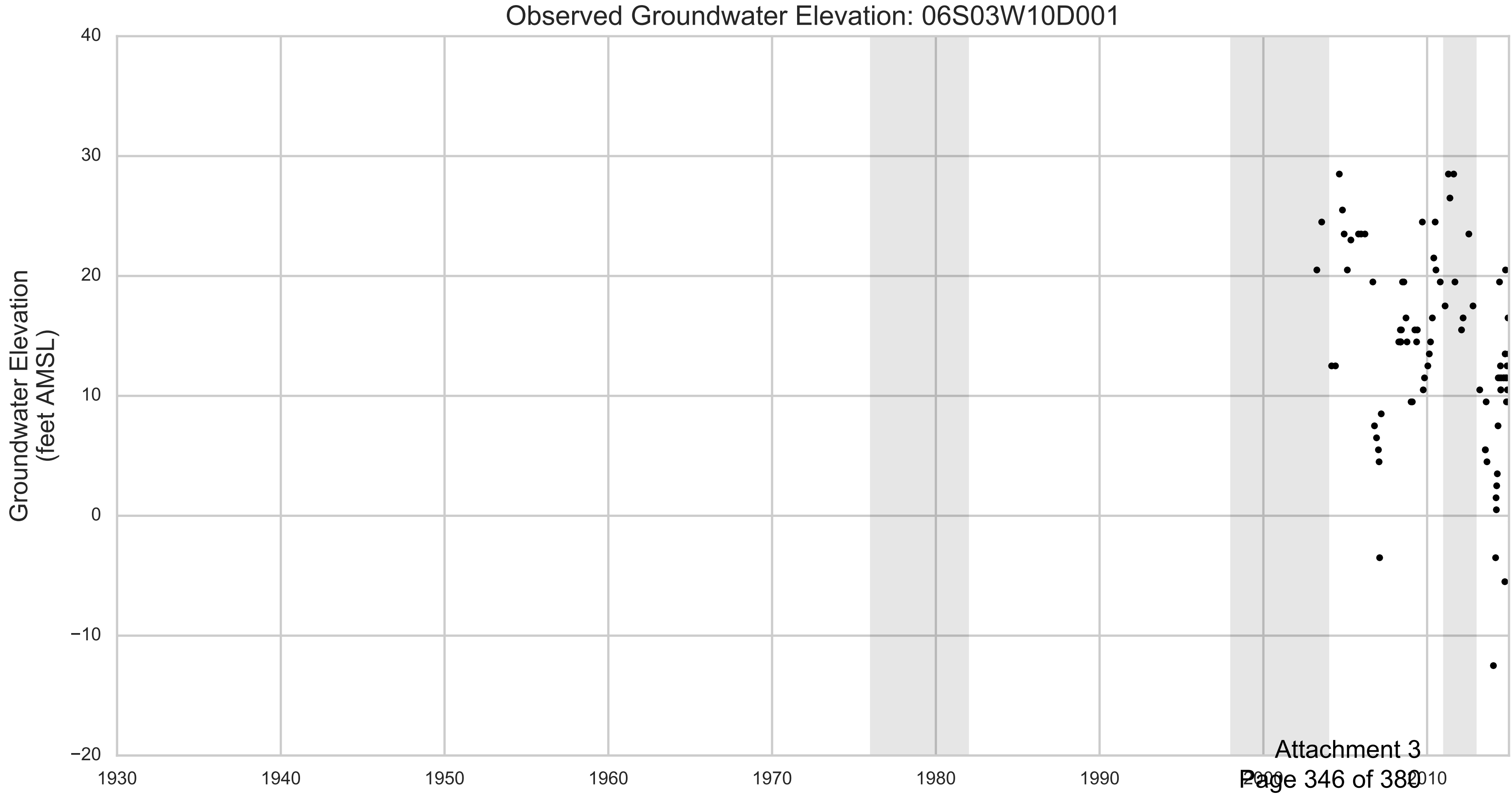
DRAFT




Cumulative Departure from Mean Annual Precipitation

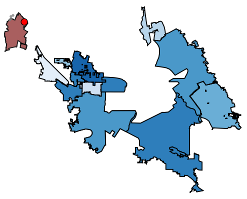

Groundwater Pumping in Stanford: RWS Area

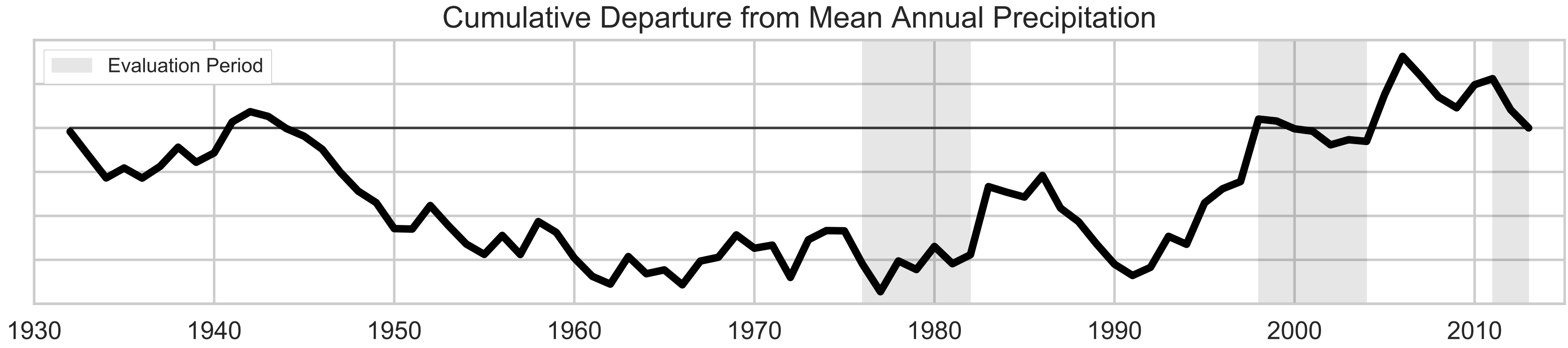

District Activity: Treated Water Delivery


Observed Groundwater Elevation: 06S03W10D001

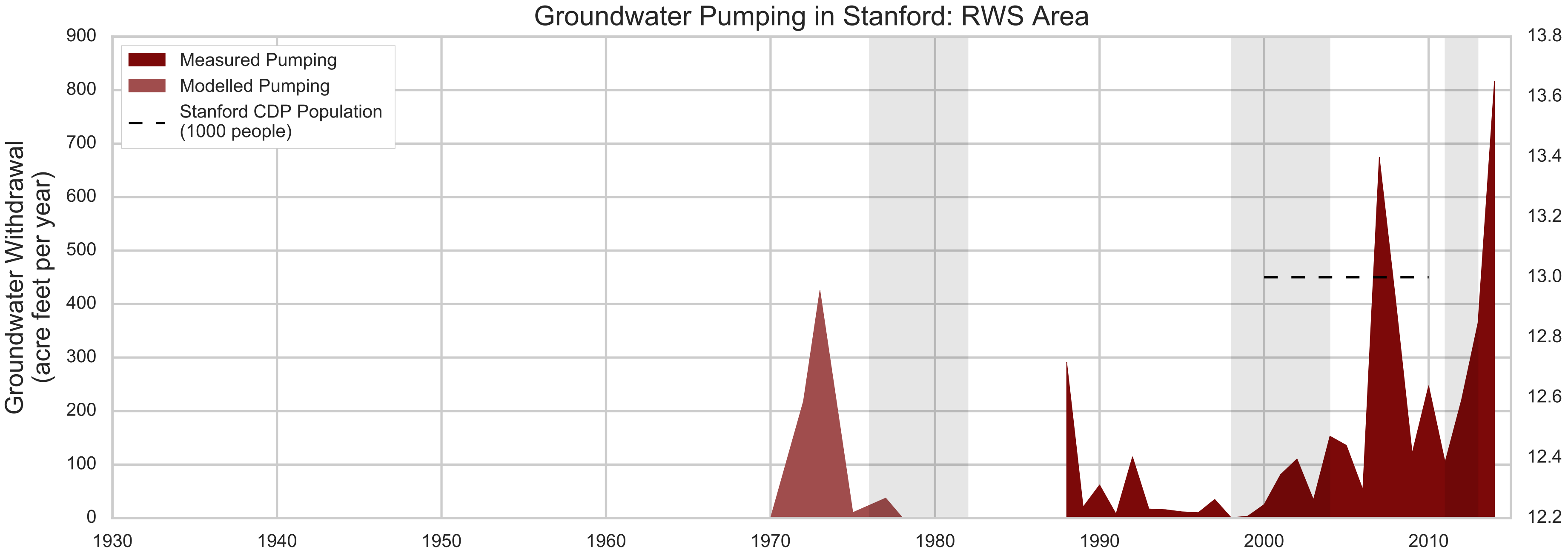
DRAFT

Monitored Pumping Wells well: 06S03W11B010
Minimum distance from activity: 15212 feet

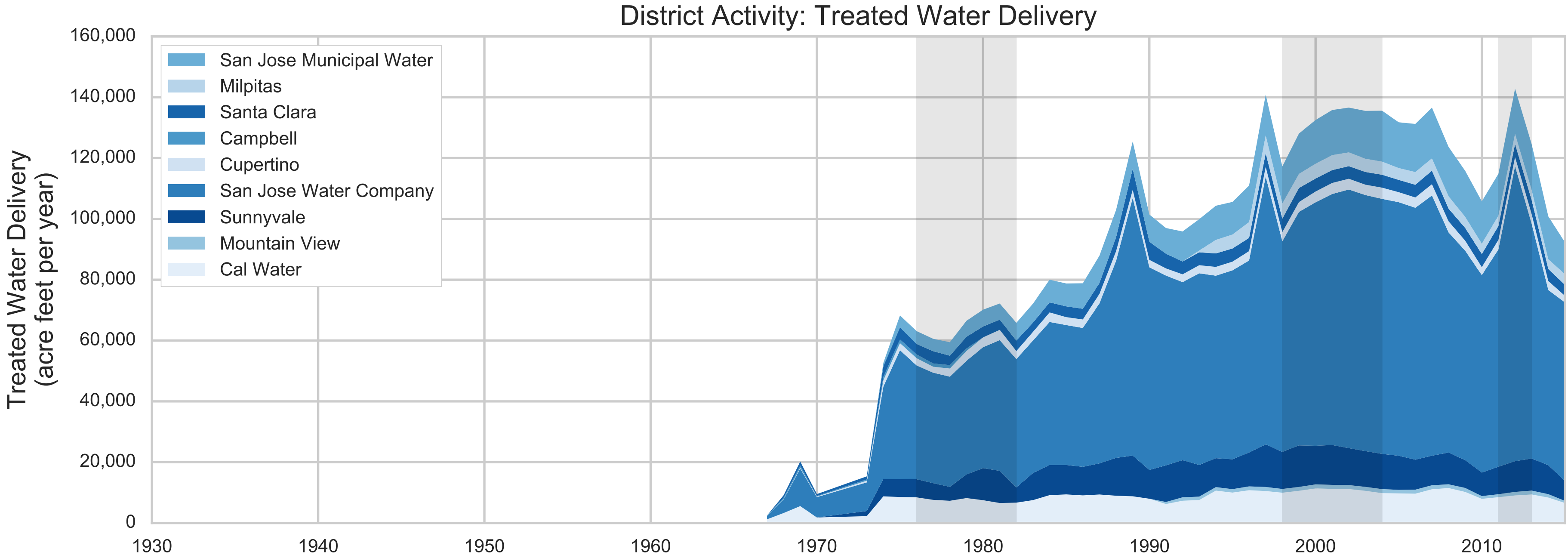




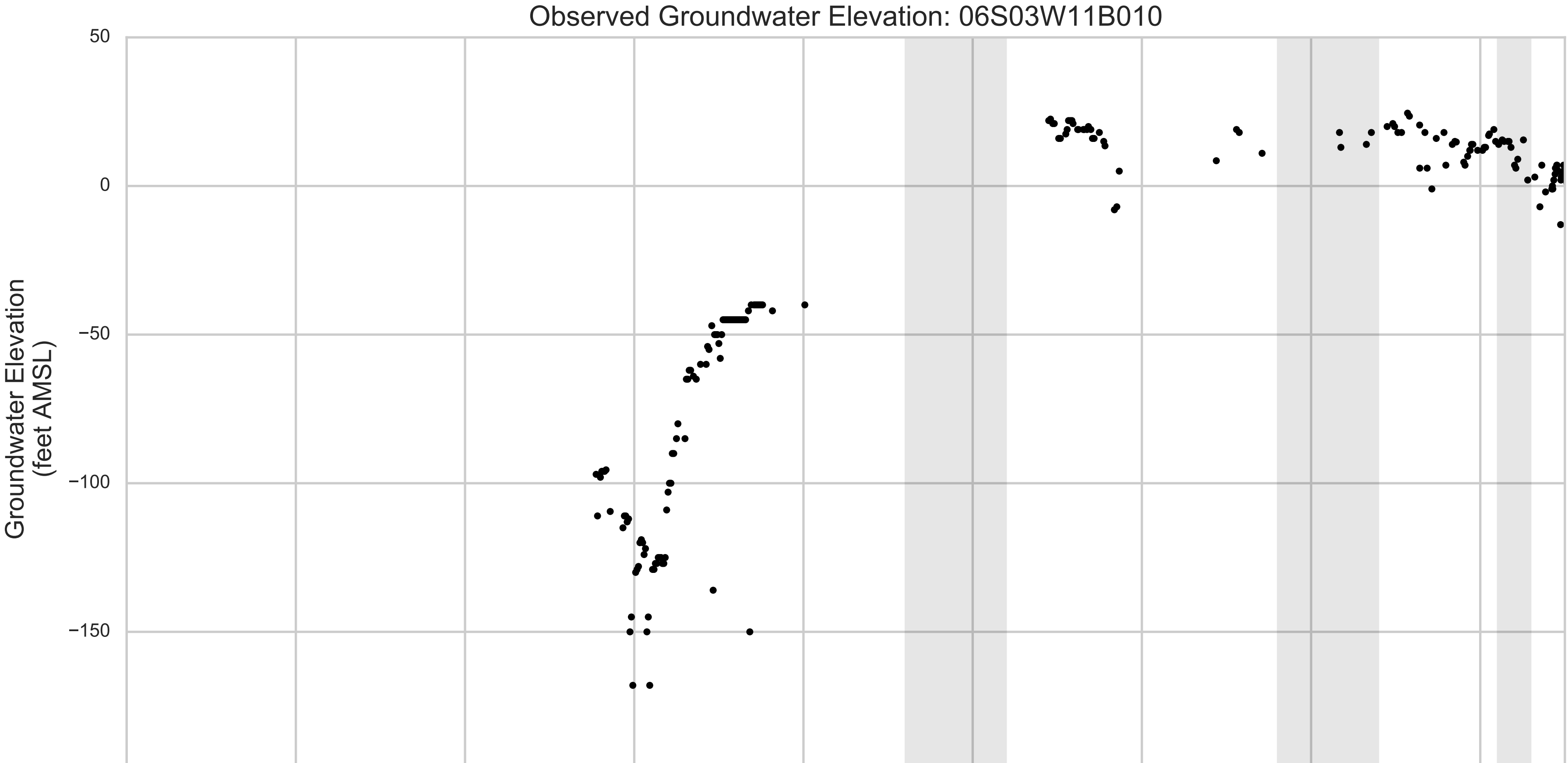
Cumulative Departure from Mean Annual Precipitation



Groundwater Pumping in Stanford: RWS Area



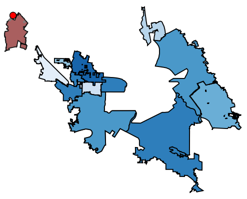
District Activity: Treated Water Delivery

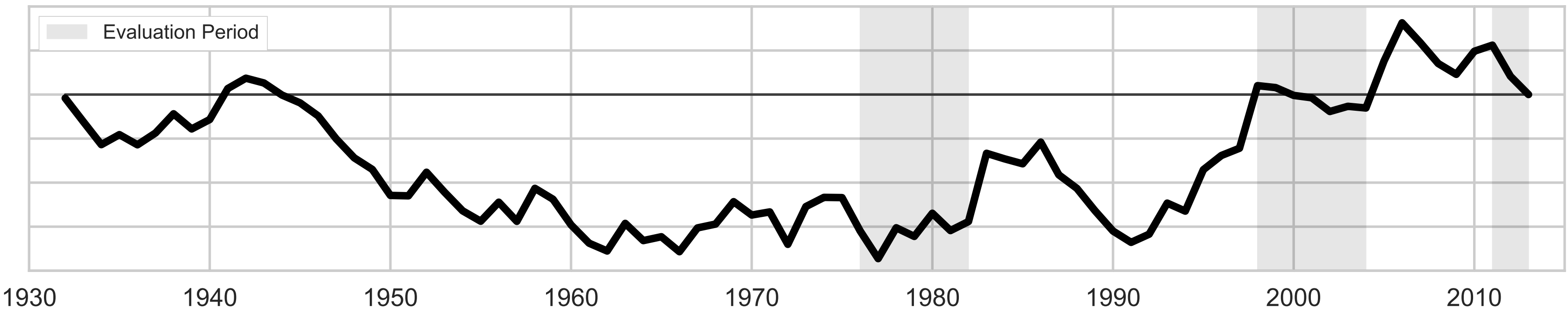


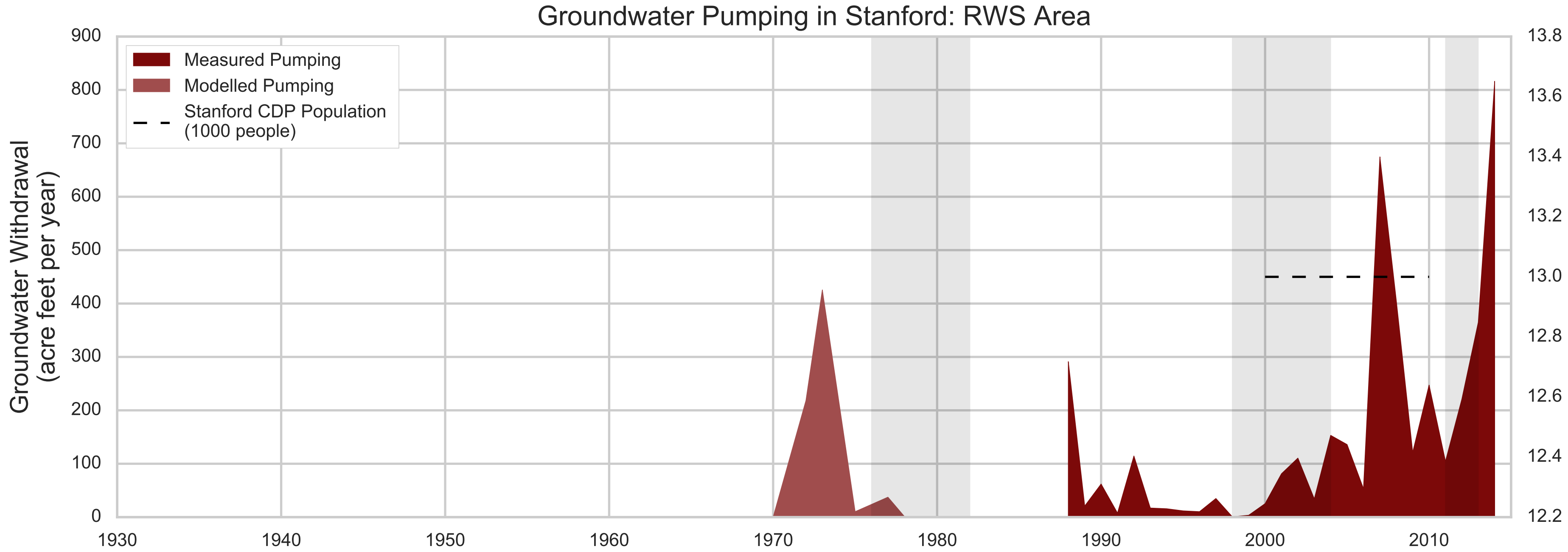
Observed Groundwater Elevation: 06S03W11B010

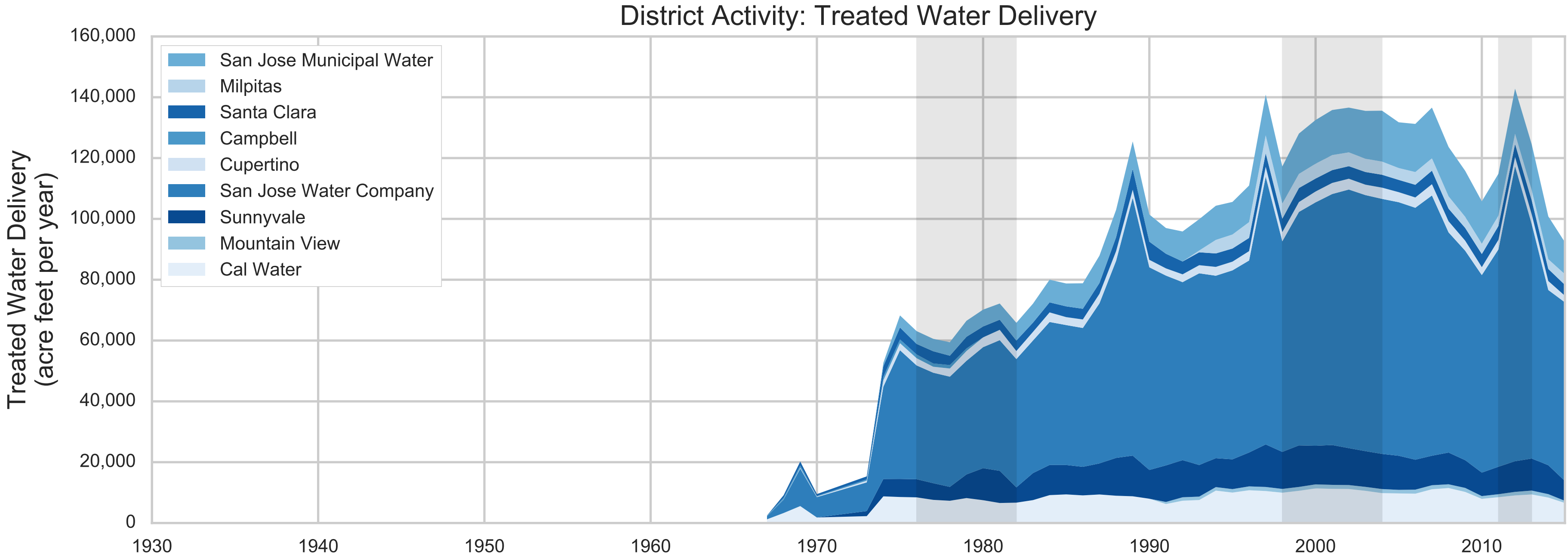
DRAFT

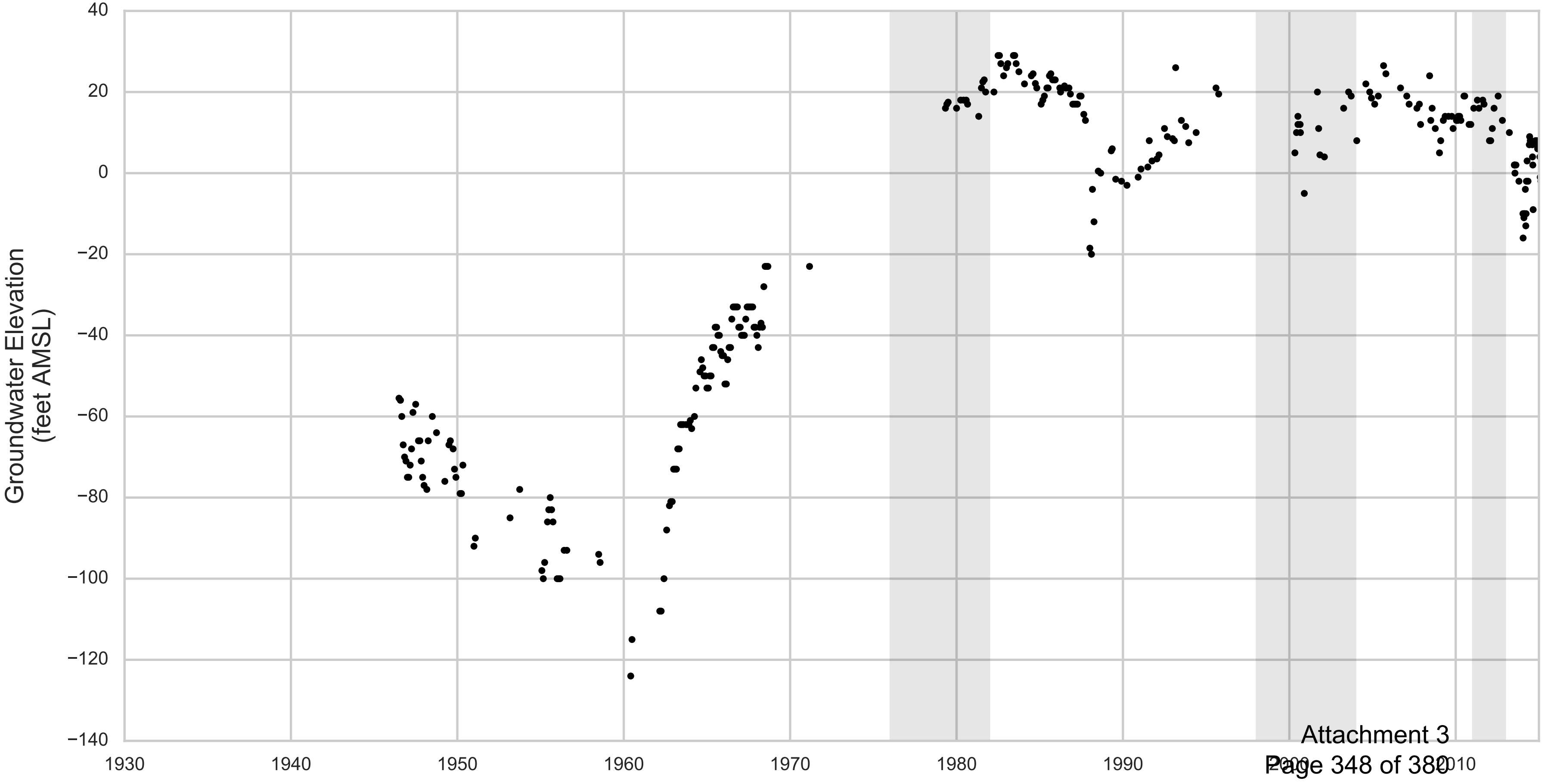
Monitored Pumping Wells well: 06S03W03L010
Minimum distance from activity: 21807 feet




Cumulative Departure from Mean Annual Precipitation


Groundwater Pumping in Stanford: RWS Area


District Activity: Treated Water Delivery


Observed Groundwater Elevation: 06S03W03L010

Monitored Pumping Wells well: 06S03W03M010
Minimum distance from activity: 22095 feet

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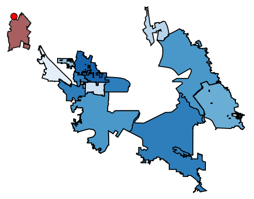
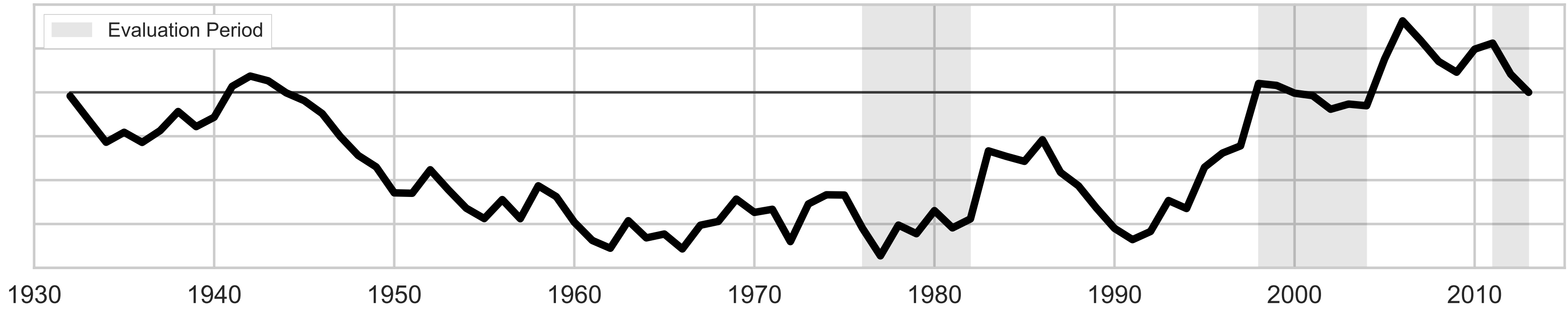
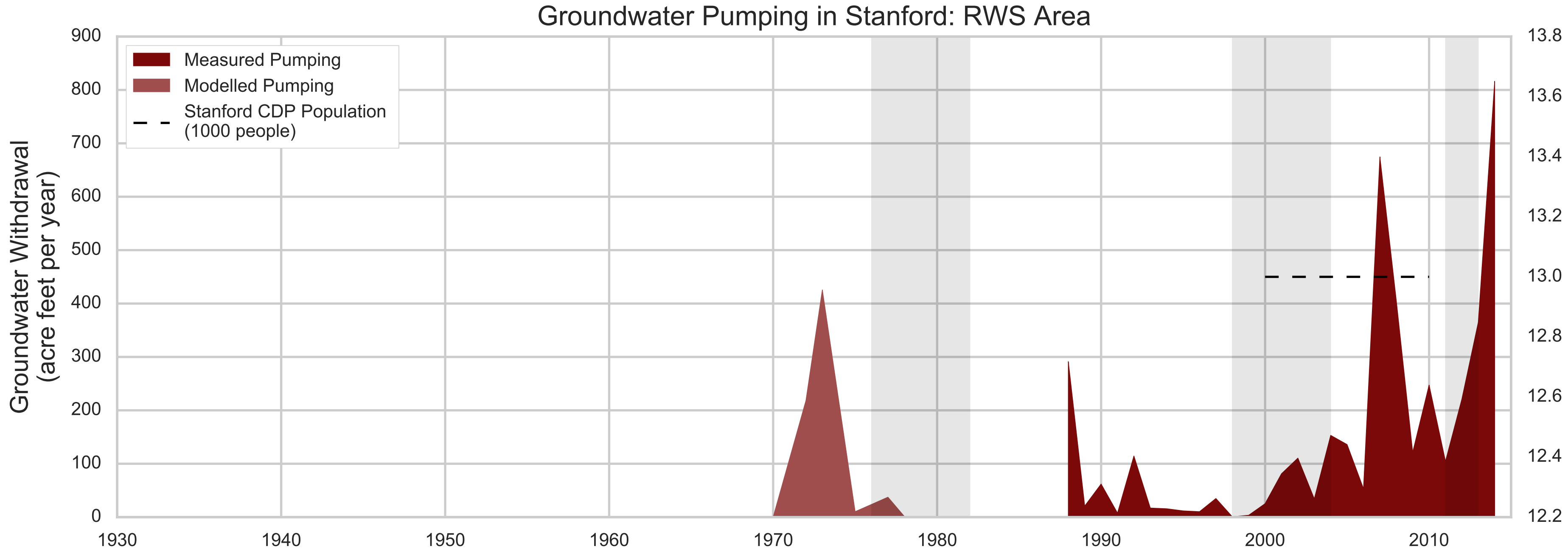


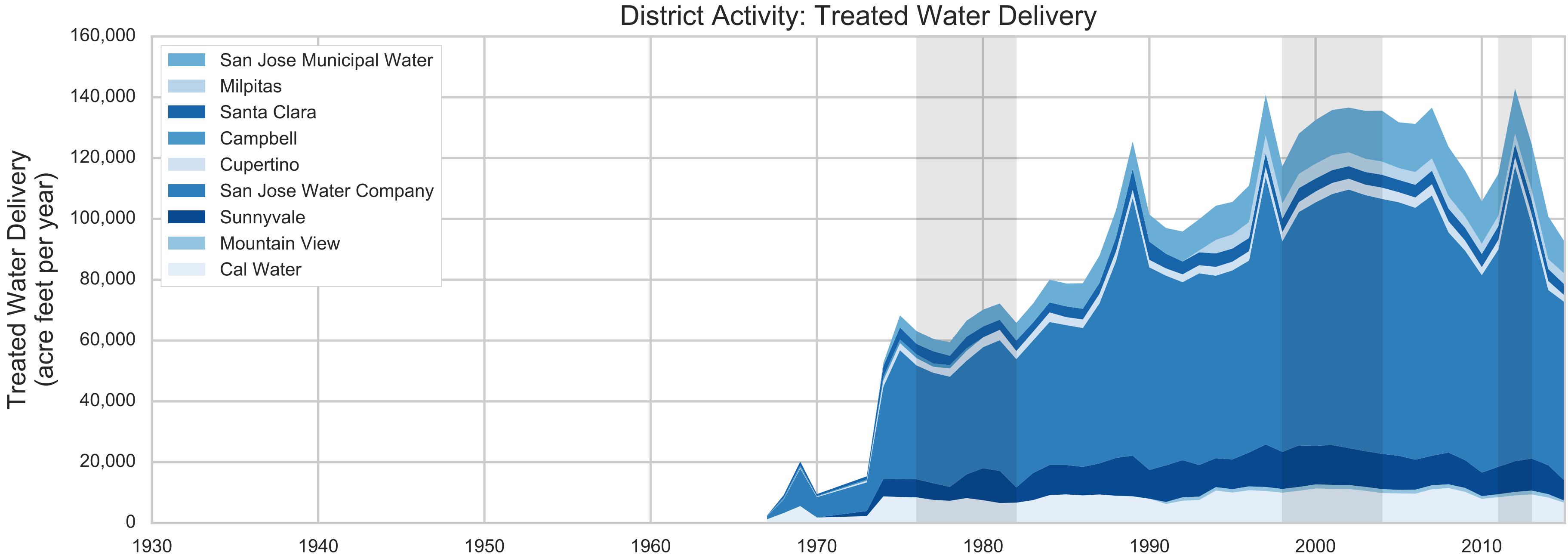
Cumulative Departure from Mean Annual Precipitation



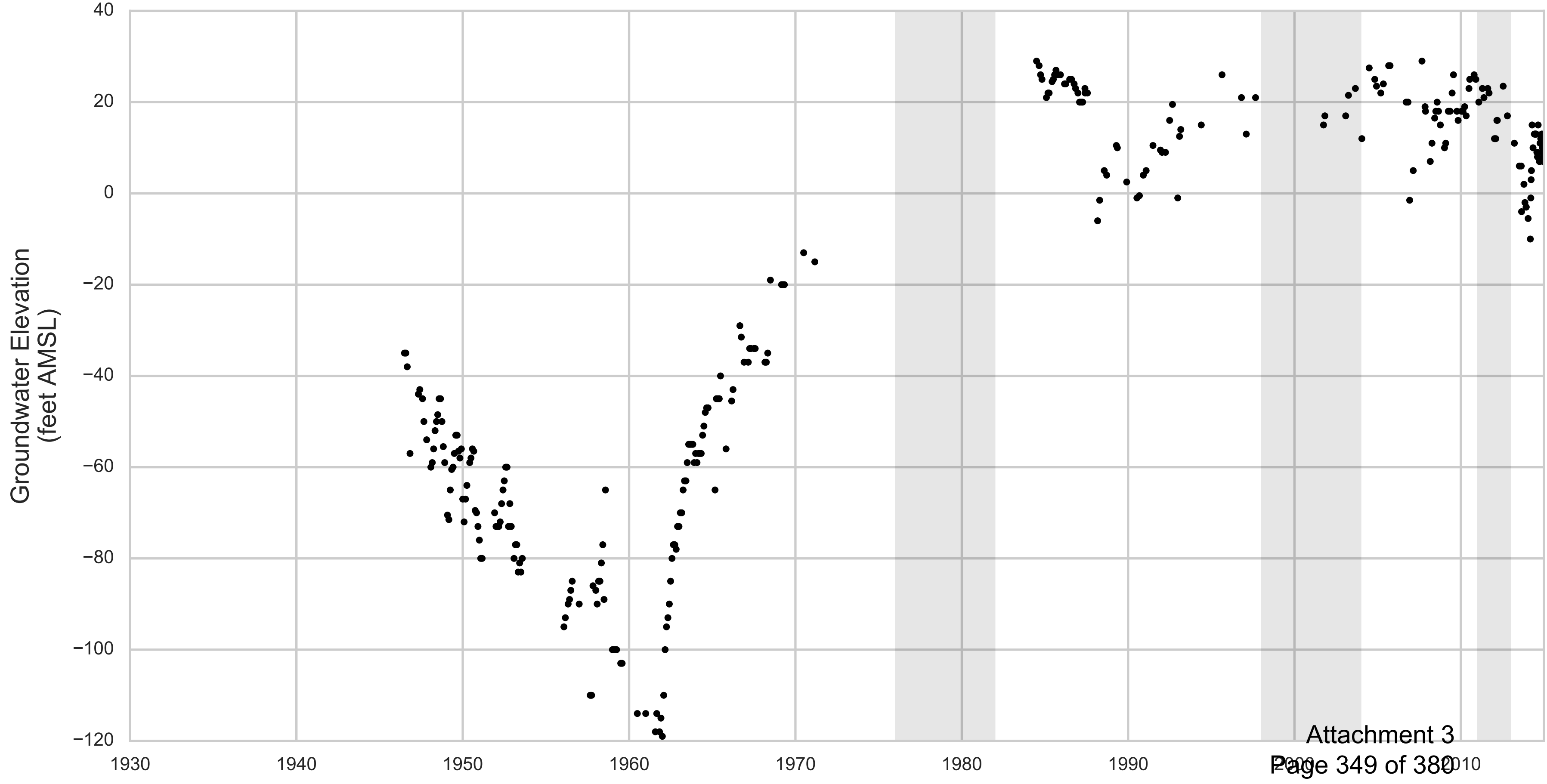
Groundwater Pumping in Stanford: RWS Area



District Activity: Treated Water Delivery



Observed Groundwater Elevation: 06S03W03M010



Stanford University

SUSTAINABILITY AND ENERGY MANAGEMENT

Vanessa De La Piedra, P.E., Unit Manager *via email to vdelapiedra@valleywater.org*
George Cook, Specialist *via email to gcook@valleywater.org*
Groundwater Monitoring and Analysis Unit
SANTA CLARA VALLEY WATER DISTRICT
5750 Almaden Expressway
San Jose, CA 95118

July 16, 2019

Subject: Zones of Benefit Study – Stanford comments on SCVWD's response to previous Stanford comments

Dear Ms. De La Piedra and Mr. Cook:

We have reviewed the responses to our 2018 May comments on the subject report, and our technical consultant, Pete Leffler at Luhdorff & Scalmanini Consulting Engineers, has prepared the accompanying Technical Memorandum with our comments on the responses. We continue to have a much different perspective on the benefits to the far north county area from the District's recharge activities, and still see no evidence of any benefits to this area in the information provided. Moreover, we continue to question whether the Zone of Benefit Study supports the basis for the District's groundwater fee.

We would welcome an opportunity to discuss our comments with you and your consultant, and I will work with George to schedule that meeting. We look forward to continuing our discussions and reaching appropriate conclusions on this important issue.

Sincerely,

Tom W. Zigterman

Tom W. Zigterman, P.E., D.DRE
Director, Water Resources & Civil Infrastructure

c: Rob Donlan, Ellison, Schneider, Harris and Donlan
Tom Elson and Peter Leffler, Luhdorff & Scalmanini Consulting Engineers
Karla Daily, Palo Alto

WATER RESOURCES & CIVIL INFRASTRUCTURE GROUP
327 Bonair Siding, Stanford, CA 94305-7272 T 650-725-8081 F 650-723-3191

Luhdorff & Scalmanini
Consulting Engineers

DRAFT

Technical Memorandum

DATE: June 28, 2019 PROJECT: 14-2-067

TO: Tom Zigterman
Stanford University

FROM: Peter Leffler

SUBJECT: **LSCE RESPONSES TO LETTER FROM SCVWD AND MONTGOMERY & ASSOCIATES, DATED NOVEMBER 20, 2018 (SCVWD) AND OCTOBER 26, 2018 (MONTGOMERY & ASSOCIATES) AND LSCE COMMENTS ON REVISED DRAFT REPORT DATED APRIL 2019**

INTRODUCTION

Santa Clara Valley Water District (SCVWD) provided a draft report entitled, "Preliminary Zones of Benefit Study, Santa Clara County, California," prepared by HydroMetrics and dated October 2017. Stanford University and Luhdorff & Scalmanini Consulting Engineers (LSCE) reviewed this study and provided comments in a letter dated May 11, 2018 from Stanford University (with attachment from LSCE dated May 7, 2018). SCVWD responded to Stanford/LSCE draft report study comments in a letter dated November 20, 2018 (with Montgomery & Associates (Montgomery) attachment dated October 26, 2018). SCVWD and Montgomery also prepared a revised draft report entitled, "Preliminary Groundwater Benefit Zones Study, Santa Clara County, California," dated April 2019. This Technical Memorandum (TM) provides LSCE responses to the November 20, 2018 letter from SCVWD (which includes the October 26, 2018 letter from Montgomery) and LSCE's comments on the revised draft report dated April 2019.

LSCE RESPONSES TO SCVWD LETTER DATED NOVEMBER 20, 2018 (WITH ATTACHMENT FROM MONTGOMERY DATED OCTOBER 26, 2018)

1. LSCE's Comment Number 1 stated in part,"…utilizing data only from a 2011 to 2013 time period, was clearly of insufficient duration to prove a benefit to the Stanford area." While not specifically stating it was in response to this comment, SCVWD/Montgomery stated that they are now also using data for the 1978 to 1982 and 1998 to 2004 time periods in their groundwater level data analysis. SCVWD/Montgomery state that Stanford Well 1 data from 1978 to 1982 shows a stable trend, and Stanford Well 1 and Well 2 data from 1998 to 2004 time period shows an increasing trend.

   LSCE Response: *The water level data from 1978 to 1982 cannot be used in this analysis because the regional trend of increasing groundwater levels from 1963 to 1984 derives from greatly* *decreased pumping by Palo Alto/Stanford between 1962 (in excess of 8,000 AFY) and 1974 (less than 1,000 AFY). Thus, the stable to increasing trend from 1978 to 1982 is clearly due to an extended recovery period from reduced local pumping, as is clearly obvious in all Palo Alto and Stanford wells with data from this time period. The Stanford Well 1 water level dataset is missing data from 1997 to 2000, making it essentially impossible to draw conclusions regarding trends from 1998 to 2004. The Stanford Well 2 dataset is similarly compromised by not having data from 1999 to 2001.*

2. LSCE's Comment Number 2 stated in part that there was a net stable to decreasing trend in water levels during the 2011 to 2013 evaluation period, and that this observation/conclusion is in contrast to the ZOB study claim of stable groundwater levels in Stanford wells during this time. The SCVWD/Montgomery response did not address this comment or make any further observations regarding the Stanford groundwater level data trends over the 2011 to 2013 time period.

   LSCE Response: *SCVWD/Montgomery apparently do not dispute LSCE's observation of the 2011 to 2013 time period being stable to decreasing in water level trends as opposed to their own statements to the contrary in the ZOB study. Instead, the SCVWD/Montgomery Response turns to two other time periods (1978 to 1982 and 1998 to 2004) in an attempt to support their claims regarding use of groundwater level data trends to support inclusion of the Stanford area in the ZOB. Our review of these two new time periods being added to the analysis is included in our response item 1, which indicate these data periods cannot be used in the analysis. Thus, there remains only the potentially valid time period of 2011 to 2013 as stated in the original ZOB study report, and one can only conclude these data do not support inclusion of the Stanford area in the ZOB.*

3. LSCE's review of groundwater level data for three different time periods as summarized above in items 1 and 2 further supports another statement in LSCE's original Comment 1 on the ZOB study, "It is important to note that the Zone of Benefits (ZOB) study provides for inclusion of the Stanford area in the ZOB based primarily on groundwater model simulation results." In contrast, SCVWD/Montgomery Response letter states, "Groundwater model simulation results are not the primary basis for inclusion of the Stanford area in the ZOB. The primary bases for inclusion of the Stanford area in the ZOB are the groundwater level trend evaluation and information about hydrogeologic connections."

   LSCE Response*: As stated above, it is clear that the groundwater level trend evaluation does not support inclusion of the Stanford area in the ZOB. Elsewhere in the SCVWD/Montgomery Response they acknowledge that, "…there are limitations in the data from, and modeling of, the Stanford area used in the study." The SCVWD/Montgomery Response makes no attempt to address or rebut the numerous comments made by LSCE regarding the model and its inadequacies to be used in the ZOB study for the Stanford area. Specifically, no responses are provided to LSCE comments 3 through 13 regarding the groundwater model used in the ZOB study.*

4. The SCVWD/Montgomery Response includes a section entitled, "Hydrogeological Connection with District Activities" that is based on their assumption that, "…benefits from a District activity extend to all areas that are connected by groundwater flow (hydrogeologically connected) to the activity." Essentially, this assumption states that whether or not an area is 0.1 miles, 1 mile, 10 miles, or 50 miles away from a District activity, it can be claimed to be within the ZOB if there is continuously mapped alluvium within that area.

   LSCE Response: *The fact that the ZOB study adopted this hydrogeological connection assumption does not make it correct or valid. A hydrogeologic connection as defined by SCVWD/Montgomery does nothing to prove a benefit is derived by a given area from District activities, it merely indicates a benefit is possible. Thus, it is not a valid assumption to state all that is required is a hydrogeologic connection, rather a hydrogeologic connection is one of multiple requirements to demonstrate a benefit from District activities. The other requirements to demonstrate a benefit are discussed above and in LSCE's original comment letter, and these other requirements are not met.*

5. The SCVWD/Montgomery Response includes a section entitled, "Concept of Proportional Benefit" that states it is not possible to developed tiered zones relative to actual benefits derived from District activities.

   LSCE Response: *Historical data demonstrate that water levels in the Stanford area are closely tied to local groundwater pumping and development of a surface water supply from SFPUC. Any potential benefits from SCVWD activities are essentially irrelevant to local groundwater levels compared to the impacts of local pumping and use of the SFPUC surface water supply. In fact, development and use of the SFPUC surface water supply by Palo Alto and Stanford (and others in the area) has greatly benefited the groundwater basin managed by SCVWD (by effectively eliminating or greatly reducing pumping from many entities) and providing a source of additional groundwater recharge from outside the basin (e.g., excess irrigation recharge). One could reasonably argue that non-SFPUC water users in the groundwater basin receive an equal or greater benefit from SFPUC water users (including Stanford and Palo Alto) compared any potential benefits received by Palo Alto/Stanford from SCVWD activities. SCVWD would have to expend considerably more money and develop new facilities closer to the Palo Alto/Stanford area were it not for development and use of SFPUC surface water by these North County entities.*

LSCE COMMENTS ON REVISED DRAFT PRELIMINARY GROUNDWATER BENEFIT ZONES STUDY, MONTGOMERY & ASSOCIATES, DATED APRIL 2019

1. Executive Summary, page 15: The revised report text refers to evaluation of water budgets for the subbasin showing the benefits of District groundwater replenishment activities, including managed recharge and in-lieu recharge, and that without these activities pumping would exceed recharge. Thus, the report claims that District activities improve groundwater levels, thereby providing benefits related to groundwater supply reliability and avoidance of land subsidence and seawater intrusion.

LSCE Comment: *The water balance discussion does not consider the significant benefits of SFPUC surface water, and associated in-lieu and other recharge, to Stanford, Palo Alto, and other North County cities. Also, no details are provided of the various components of natural recharge and District activities to allow for peer review and validation of the summarized water balance in the revised draft report.*

2. Section 2.2, pages 27-28: The revised report text describes the history of SCVWD activities and associated rise/fall of groundwater levels in the basin. This discussion includes a statement that SFPUC water was delivered to north Santa Clara County in the 1950's, but groundwater pumping continued to increase and groundwater levels continued to fall. This discussion implies that delivery of SFPUC water to the Stanford/Palo Alto area did not resolve groundwater level issues in this area.

   LSCE Comment: *Significant deliveries of SFPUC surface water to the Stanford/Palo Alto area did not start until the early 1960's (approximately 1962). There was an immediate and dramatic response (recovery) in groundwater levels when Stanford/Palo Alto (and others) switched from groundwater pumping to SFPUC surface water supplies in the early 1960's. This recovery lasted at least through the 1980's, clearly correlated to onset of surface water supply use (instead of groundwater pumping) from the SFPUC RWS system. It is clear that the groundwater system budget deficit in the north Santa Clara County area was solved by SFPUC system surface water.*

3. Section 2.3, page 29: The report text states that, "Benefits from a District activity extend to all areas that are connected by groundwater flow (hydrogeologically connected) to the activity."

   LSCE Comment: *This statement/criteria effectively makes all other analyses conducted to show benefits from SCVWD activities for the study unnecessary (e.g., groundwater level evaluation, groundwater modeling). This statement/criteria says that in areas of interconnected alluvium (which could be argued to extend north at least to the northern end of San Mateo Plain west of the Bay and incorporate Niles Cone and possibly East Bay Plain east of the Bay), groundwater pumpers are receiving benefits from District activities that are significant enough to warrant a charge/fee from SCVWD for groundwater pumping. The cut-off of charging for this fee at the San Mateo -Santa Clara County line is a jurisdictional boundary and not a hydrogeologic boundary per this statement. Stanford is located approximately 10 miles north of any SCVWD recharge activity in an area shown to be dramatically influenced by SFPUC surface water use. If not for use of SFPUC surface water in the early 1960's by Stanford, Palo Alto, and others, SCVWD would have had to invest in several additional recharge facilities in this area to provide the recovery in groundwater levels brought about by the SFPUC surface water use in the North County area.*

4. Section 3.2, page 31: The revised report text states, "Natural recharge is insufficient to support groundwater pumping in the subbasin…"; and

Section 3.3, page 32: The revised report text states, "Current groundwater pumping exceeds natural recharge…"

***LSCE Comment**: Natural recharge in the North County area (e.g., San Francisquito Creek, rainfall recharge, bedrock inflow, etc.), Stanford Lake Lagunita recharge, and other sources of recharge are likely more than sufficient to support current/recent groundwater pumping by Stanford and Palo Alto.*

5. Section 4, page 35: The report text provides a high level water budget summary for the year 2013.

   ***LSCE Comment**: 2013 represents the second year of a severe drought and is not representative of average conditions for natural recharge.*

6. Section 4.1, page 35: The report text states, "On average, groundwater accounts for forty percent of the water used in Santa Clara County. Groundwater pumping (approximately 150,000 acre-feet in 2013) far exceeds natural recharge."

   ***LSCE Comment**: These statements do not apply to Stanford (or Palo Alto) and likely others in the North County area.*

7. Section 4.2, page 37: The report text states, "…additional evaluation is required to associate the subsidence benefits to specific sets of District activities and account for other sources of recharge such as rainfall or in-lieu supplies of surface water from San Francisco Public Utilities Commission (SFPUC) Regional Water System (RWS)." A similar statement is made with regard to salt water intrusion on page 39 of the revised draft report.

   ***LSCE Comment**: It is not clear where in the revised draft report this additional analysis was conducted, and results provided related to accounting for recharge/in-lieu supplies from SFPUC RWS.*

8. Section 5.1.2, page 45: The revised draft report text states, "Unconsolidated Alluvium is mapped from the northern to the southern boundary of Santa Clara County." Section 5.4 (page 53) of the revised draft report states, "The 2015 USGS report (Wentworth et al., 2015) identifies continuous sedimentary stratigraphy from San Jose to the Palo Alto area." Section 6 (page 59) of the revised draft text states, "Water budgets for potentially hydrogeologically connected areas demonstrate the benefits form the District's groundwater replenishment activities."

   ***LSCE Comment**: Unconsolidated Alluvium essentially extends all around (East Bay north to Richmond, South Bay, West Bay up to at least Foster City) and beneath San Francisco Bay. Thus, the concept of demonstrating that a given area benefits from SCVWD activities as solely demonstrated by hydrogeologic connection of continuous alluvium is effectively meaningless. If this were true, then the Zone of Benefits Study would have only needed to provide a geologic map of alluvium and no other work needs to be done to prove a benefit from SCVWD activities. All the other evaluations and discussions in the report related to groundwater levels and* *groundwater modeling are unnecessary, because regardless of the outcome of those analyses the report will conclude a benefit exists for all areas within the study area simply because they are underlain by alluvium. In fact, this reasoning/rationale means that benefits from SCVWD activities would extend to a given area no matter how far away it is from SCVWD recharge facilities, including well beyond the boundaries of Santa Clara Valley Water District. While a hydrogeological connection is part of the requirements to prove a benefit from SCVWD activities, other requirements must also be met to prove a benefit.*

9. Section 6.1 page 59: The revised draft report states, "Natural recharge is not sufficient to support groundwater pumping in the subbasin…Groundwater replenishment activities are needed to balance groundwater pumping with total recharge…If groundwater pumping were to exceed recharge, groundwater levels would decline, resulting in…increased risk of land subsidence and saltwater intrusion. The plots show that groundwater replenishment activities are needed in all years."

   LSCE Comment*: This water budget analysis completely ignores vast differences in local water budgets compared to the District-wide water budget and ignores the use of SFPUC surface water in the Stanford/Palo Alto and surrounding North County region. Given the minimal groundwater pumping, the water budget in the Stanford/Palo Alto area likely even has recharge in excess on groundwater pumping, thereby providing benefits to the rest of the basin. Groundwater level declines in the Stanford/Palo Alto area are prevented by use of SFPUC surface water in the area. If SFPUC surface water were not used, the SCVWD would have to install very expensive managed recharge facilities in the Stanford/Palo Alto area to prevent groundwater declines and reduce potential for land subsidence and sea water intrusion.*

10. Section 6.3, page 66: The revised draft report text states, "Recycled water deliveries by the Palo Alto…Water Recycling systems supported by the District that reduces groundwater pumping…" and Section 7.3, page 73 states recycled water deliveries, "…are a relatively small part of the overall budget and therefore the effect is not expected to be observed in the groundwater level evaluation."

    LSCE Comment*: What groundwater pumping in the Stanford/Palo Alto area is being reduced by this activity, where SFPUC surface water is the primary source of supply? Furthermore, the report essentially says these recycled water deliveries are insignificant and local basin benefits cannot be quantified.*

11. Section 8, page 77: The revised draft report text item 2.b states that the groundwater level evaluation conducted for the report looked at time periods where groundwater levels would be expected to decline without SCVWD activities and, if groundwater levels during these time period were instead stable or increasing, a benefit from SCVWD activities is demonstrated. However, it goes on to say that even if groundwater levels show a declining trend during these selected time periods, it, "…does not indicate lack of benefit from District activities as the District activity may still be benefitting by limiting the decline in groundwater levels." In

addition, under Section 8.1 on page 77, the revised draft report text states, "Decreasing groundwater level trends are likely to be observed in many evaluation periods even with benefits from District activities occurring due to the rainfall and area pumping conditions."

***LSCE Comment**: Effectively, this report text states that no matter whether the trend in groundwater levels in these specially selected time periods is increasing, stable, or decreasing, a benefit from SCVWD activities is demonstrated. Why bother to do this analysis because the report derives the same conclusion (any given area benefits from SCVWD activities) regardless of the outcome of the analysis?*

12. Section 8.1.2.1, page 79: The report text states, "…the Study maps retailer areas receiving water from San Francisco Public Utilities Commission's RWS supplies…" and shows a map of these areas in Figure 26 on page 80.

    ***LSCE Comment**: The map shows a very large area of SFPUC RWS water supplies for the region from Stanford/Palo Alto extending south and east to San Jose Water Company's service area and east to the east bay hills. The report does not address the benefits derived from SFPUC RWS water to the area in its evaluation of groundwater level trends and other analyses.*

13. Section 8.1.3, page 89: The report text states, "The Study does not evaluate managed recharge of imported water separately from managed recharge of local runoff because all managed recharge systems in Santa Clara Subbasin are connected to imported water supplies."

    ***LSCE Comment**: The Study does not quantify (and subtract) the amount of local runoff that would recharge the basin anyway without SCVWD facilities, but rather assumes all that natural recharge from stream infiltration is due to SCVWD facilities.*

14. Section 8.2.4, page 111: The report text describes various time periods for Palo Alto and Stanford where the Study claims groundwater level trends show benefits from SCVWD activities.

    ***LSCE Comment**: The time periods 1975-1982 and 1978-1982 are greatly impacted by the ongoing long-term groundwater level recovery trend from the region converting from primarily groundwater use to SFPUC RWS supply in the 1960's and cannot be used for groundwater level evaluation in the Study. The 1998-2002 time period represents part of a longer-term recovery from increased groundwater pumping during the drought in the late 1980's/early 1990's and cannot be used for groundwater level evaluation in the Study. The 2011-2013 time period actually shows stable to decreasing groundwater level trends and does not support the Study conclusion of demonstrating benefits from SCVWD activities. Overall, none to the selected time periods for the Stanford and Palo Alto groundwater level evaluation support the Study conclusion of demonstrating benefits from SCVWD activities in this North County region.*

City of Palo Alto Comments and Valley Water Responses

July 20, 2019

Mr. George Cook:

Thank you for the opportunity to comment on Valley Water's Preliminary Groundwater Benefit Zones Study. The City of Palo Alto (Palo Alto) imports 100% of its potable water supply from the San Francisco Public Utilities Commission Region Water System (RWS or Hetchy Hetchy). Several other retail water agencies in the Northwest County also heavily rely on RWS water, benefiting the groundwater basin.

After Valley Water released a draft of the Benefit Zones Study several months ago, Palo Alto provided informal feedback to staff requesting a more thorough explanation of how Hetch Hetchy imports have been taken into account in the analysis. Palo Alto remains concerned that the full benefit of that imported water has not been fully factored in. The Benefit Zones Study relies heavily on modeling and "hydrogeologic connectivity", extending even beyond the county line, but that concept is not demonstrated in the report.

Stanford University, another Hetch Hetchy importer in the Northwest County, provided Valley Water with a Technical Memorandum (TM) dated June 28, 2019 from Luhdorff and Scalmanini Consulting Engineers. Palo Alto concurs with the findings in the TM and urges Valley Water to address the shortcomings in the findings. We look forward to working with you to come to a mutually agreeable resolution.

Sincerely,

DocuSigned by:
Ed Shikada
F2DCA19CCC8D4F9...

Ed Shikada

City Manager

Great Oaks Water Company Comments and Valley Water Responses

GREAT OAKS WATER COMPANY
P. O. BOX 23490
SAN JOSE, CA 95153
(408) 227-9540
tguster@greatoakswater.com

January 7, 2019

Sent Via Email

George Cook (*gcook@valleywater.org*)
Associate Engineering Geologist
Groundwater Monitoring and Analysis Unit
Santa Clara Valley Water District

RE: Comments and Questions to Preliminary Groundwater Zones of Benefit Study Prepared by HydroMetrics Water Resources Inc. (HydroMetrics WRI)

Dear Mr. Cook:

These comments and questions are submitted on behalf of Great Oaks Water Company (Great Oaks) and pertain to the HydroMetrics WRI Preliminary Groundwater Zones of Benefit Study (Preliminary Study) dated October 2017. As several questions are included in this submission, Great Oaks' comments are to be considered preliminary, as the answers to those questions may result in additional comments and questions.

How, when, or if the Preliminary Study will be presented to the Santa Clara Valley Water District (District) Board of Directors (Board) for information and/or action is unclear. Great Oaks' first request is for the District to provide information about what the District intends to do with the Preliminary Study and when any such action is scheduled to take place. Please provide that information to Great Oaks and all other interested parties, including all water "retailers" in a timely manner that provides an opportunity to participate in any such action.

General Comments

1. District Activities Considered in Preliminary Study.

Based upon the October 31, 2017 Draft Technical Memorandum from Hydrometrics WRI to you, it is understood that the Preliminary Study only considered demonstrated benefits from two District activities when proposing zones of benefit: (1) managed aquifer recharge; and (2) delivery of treated water. According to that Memorandum, benefits from recycled water delivery support, untreated surface water deliveries, indirect potable reuse, and potential reuse are "either small, difficult to measure, or difficult to separate from the benefits of the two primary District activities."[1]

District activities are discussed in Section 5 of the Preliminary Study. Managed recharge and treated water deliveries are the first two activities discussed, but the Preliminary Study also includes discussion of District activities noted in the Draft Technical Memorandum – recycled water (Section 5.3) and surface water deliveries (Section 5.4). District conservation activities are also discussed in Section 5.5. It is believed, however, that consistent with the Memorandum, the beneficial effects, if any, of recycled water, surface water deliveries, and conservation activities were not factors used to propose or determine zones of benefit.

Great Oaks requests that the District confirm that only the beneficial effects, if any, of District managed recharge and delivery of treated water were and are to be considered when determining zones of benefit. Kindly advise if this is true for the Great Oaks and North Morgan Hill areas. This confirmation will permit a more focused approach to reviewing the methodology and conclusions of the Preliminary Study.

2. Groundwater Level Data Evaluation.

The Preliminary Study evaluates whether, during identified periods for evaluation, observed groundwater level data in a particular area shows a stable or increasing trend which indicates a benefit from a District activity.[2] The three factors considered to identify evaluation periods were rainfall, area pumping, and quantities of treated water deliveries and managed recharge provided by District activities.[3] One of those particular areas evaluated under this methodology is the Great Oaks pumping area, which is defined as Great Oaks' service area as shown in the California Public Utilities Commission grid maps.[4] The Preliminary Study correctly notes that Great Oaks' sole source of water is groundwater.[5]

It appears that the following periods were selected for evaluation for District-managed recharge: (1) 1942 – 1965; (2) 1975 – 1982; (3) 1987 – 1992; (4) 1998 – 2001; and

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[1] Preliminary Study, Appendix L, page 1.

[2] *Id.*, at page 40.

[3] *Id.*

[4] *Id.*, at page 43.

[5] *Id.* Please also note Table 2 on page 34 which does not include the Great Oaks area among those receiving District treated water.

(5) 2006 – 2013.[6] In this regard, it should be noted that Great Oaks was established in 1959, so there was no pumping by Great Oaks prior to that time. Any decreasing groundwater levels in the Great Oaks area prior to 1959 cannot be in any way related to groundwater pumping by Great Oaks. Great Oaks did not begin water production in the North Morgan Hill area until May of 2005, so any decreasing groundwater levels in that area prior to May of 2005 cannot be attributed to Great Oaks' water production. Kindly confirm if this is a correct assessment.

According to the data provided on Table 4 of the Preliminary Study, during the period from 1959 through 1965, groundwater levels in the Great Oaks area were increasing. It appears that the Preliminary Study is crediting the District managed recharge for the increasing groundwater levels during this period of time more than fifty years ago. Great Oaks requests that the District advise Great Oaks if this is a correct interpretation of the data provided in the Preliminary Study. It would also be useful to know exactly where the District managed recharge activities occurred during this time period.

Also, according to the data provided on Table 4 of the Preliminary Study, there is insufficient data for the 1975 – 1982 and 1987 – 1992 evaluation periods to make any determination of whether District managed recharge had any beneficial effect on groundwater levels in the Great Oaks area for those time periods. Great Oaks requests that the District advise Great Oaks if this is a correct interpretation of the data provided in the Preliminary Study.

Then, Table 4 shows that during the 1998 – 2004 and 2006 – 2013 evaluation periods, groundwater levels were decreasing in the Great Oaks area during 1998 – 2001 and 2009 – 2013. This appears to be indicative of there being no demonstrable benefit from District managed recharge in the Great Oaks area during those time periods. Great Oaks requests that the District advise Great Oaks if this is a correct interpretation of the data provided in the Preliminary Study.

Table 5 of the Preliminary Study provides data pertaining to groundwater level trends during time periods of District treated water deliveries. The evaluation periods shown on Table 5 are: (1) 1975 – 1982; (2) 1987 – 1992; (3) 1998 – 2004; and (4) 2006 – 2013.

The Great Oaks area is listed on Table 5, although no treated water deliveries have ever been made to that area. The treated water deliveries by the District during this period of time also appear to have been made to areas that are relatively distant from the Great Oaks area. Please explain all of the factors involved in including the Great Oaks area on Table 5.

Table 5 also shows that groundwater level trends during the 1998 – 2004 and 2009 – 2013 time periods were decreasing. This appears to be indicative of there being no demonstrable benefit within the Great Oaks area from District treated water deliveries during those time periods. In fact, the Preliminary Study states, with respect to decreasing groundwater level trends during evaluation periods:

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[6] *Id.*, Table 4, at page 54.

> In Appendices C-F, plots of groundwater level data by area stacked with the plots of rainfall, pumping by area, District activity quantities are shown with the shaded evaluation periods identified. If the plotted groundwater level trends during the shaded periods are stable or increasing, a benefit from a District activity during that period is demonstrated.[7]

Appendix C includes data plotted for the Great Oaks area for "Managed Recharge" and Appendix D includes data plotted for the Great Oaks area for "Treated Water Delivery." The data in Appendices C and D appear to correlate to the data provided in Tables 4 and 5. Great Oaks requests that the District advise Great Oaks if this is a correct interpretation of the data provided in the Preliminary Study.

Great Oaks also requests that the District indicate whether the benefits the Great Oaks area allegedly receives from District managed recharge and District treated water deliveries are direct or indirect benefits. If the benefits are said to be "indirect," please provide a full technical analysis supporting this conclusion. If the benefits are said to be "indirect," please provide a full technical analysis supporting this conclusion as well.

Finally, with respect to the groundwater level data evaluation provided in the Preliminary Study, it appears that there has been no demonstrable benefit in the Great Oaks area from District managed recharge since 1966 or from District treated water deliveries since 1982. Great Oaks interprets this data to mean that for approximately 53 years the District has no data supporting the conclusion that the Great Oaks area has benefitted from District managed recharge and for approximately 36 years the District has no data supporting the conclusion that the Great Oaks area has benefitted from District treated water deliveries. Despite this lack of data, however, the Preliminary Study concludes that Great Oaks should pay for benefits from both District activities through the groundwater charge levied in Zone A. And, the Preliminary Study concludes that the Great Oaks area should pay exactly the same amount as the areas where the treated water deliveries were actually made (*i.e.*, no attempt was made to allocate costs based upon actual, observed benefits even during times when no benefit was observed).

A better explanation is needed to explain why, in the absence of data demonstrating benefits, that Great Oaks will continue to be charged for benefits the District cannot demonstrate were provided. It appears that in proposed Zone A, Great Oaks would be paying the same amount (per Acre-Foot of water produced) as all other groundwater producers in that Zone when the data in the Preliminary Study indicates that such an allocation of costs to Great Oaks would be unreasonable and lacking in evidentiary support.

3. Hydrogeologically Connected Areas.

It may be that the Preliminary Study is relying upon the concept of hydrogeologic connectivity to conclude the Great Oaks area receives benefits from District activities in the absence of data supporting that conclusion. The Executive Summary indicates that the Preliminary "Study is based on the premise that benefits from District activities extend throughout areas connected by groundwater flow (called hydrogeologically connected areas) that occurs in similar geologic deposits."[8] This suggests that if a District activity provides any measurable (or theoretical) benefit to one portion of a hydrogeologically connected area, then that benefit is simply deemed to be provided to the entire hydrogeologically connected area in exactly the same manner and amount. Please confirm if this is how the concept of hydrogeologic connectivity is employed in the Preliminary Study.

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[7] Id., at page 49.

District delivery of treated water serves as an example of this practice. As discussed above, no demonstrable benefits have been provided to the Great Oaks area from District treated water deliveries for approximately 36 years. Yet, the Preliminary Study concludes that the Great Oaks area should be charged for benefits from District treated water deliveries to others in the Santa Clara Plain in exactly the same manner and amount.

Interestingly, the Preliminary Study concludes that the North Morgan Hill area has also received no demonstrable benefits from District managed recharge since 1982 and has never received demonstrable benefits from District treated water deliveries.[9] The Preliminary Study, however, concludes that the North Morgan Hill area should be charged for benefits associated with District managed recharge, but not for benefits from District treated water deliveries, despite the fact that the North Morgan Hill area is part of the Santa Clara Plain.

The Preliminary Study separates the North Morgan Hill area of the Santa Clara Plain from the proposed Zone A through this explanation:

> [T]he treated water delivery is north of Coyote Narrows where a steep groundwater gradient potentially limits hydrogeologic connection. Therefore, it is more likely that the increasing groundwater level trends occurring during 1975-1982 are a result of managed recharge from Coyote Creek in the Coyote Valley area instead of treated water delivery to the north of Coyote Narrows.[10]

Based upon this explanation, the Preliminary Study concludes that the North Morgan Hill area should not be charged for costs associated with District treated water deliveries and should instead be in an area designated as Zone C, where only costs associated with District managed recharge are allocated.

Great Oaks requests that the District confirm that it is the relatively steep groundwater gradient in the Coyote Narrows that is the basis for this separation of the North Morgan Hill area from proposed Zone A. Great Oaks requests that this explanation discuss the details of how steep a groundwater gradient must be to overcome the general concept of hydrogeologic connectivity within the Santa Clara Plain. Great Oaks also requests information about and examples of other types of localized hydrogeologic features within the

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[8] *Id.*, at page ES-3.
[9] *Id.*, at Tables 4 and 5, pages 54 and 55. *See also*, page 68.
[10] *Id.*, at pages 68 – 69.

Santa Clara Plain remove or reduce hydrogeologic connectivity within the groundwater basin.

Time Periods

The Preliminary Study appears to rely upon an arguably claimed benefit from treated water deliveries last observed during the 1975 to 1982 evaluation period to conclude that the Great Oaks area benefits from District treated water deliveries. And, it also appears to rely upon an arguably claimed benefit from District managed recharge last observed in 1966 – more than fifty years ago – to conclude that the Great Oaks area benefits from District managed recharge.

The time periods during which the alleged benefits were observed raises the question of how much time must pass with no observable benefits from either District managed recharge or District treated water deliveries before it is decided that those benefits are non-existent in the Great Oaks area. What information can you provide on this issue? Is it reasonable to conclude a benefit is being received if beneficial effects of a District activity have not been observed for 36 or even more than 50 years?

Conclusion

There is a great deal of information in the Preliminary Study, but the Preliminary Study also lacks essential information in several respects. Great Oaks hopes that through a continuing dialog more information will be provided, including the information requested in this letter. Through that continuing dialog, Great Oaks will work with the District to help refine the methodology and outcome of the Preliminary Study before action is taken by the District to implement the Preliminary Study's recommended zones of benefit.

If any of the observations or requests for information are in any way unclear, please contact the undersigned directly so that any such issues may be resolved as quickly as possible.

Respectfully submitted,

Tim Guster

Timothy S. Guster
Vice President and General Counsel
Legal and Regulatory Affairs

cc: Jennifer De La Piedra (via email)

GREAT OAKS WATER COMPANY
P. O. BOX 23490
SAN JOSE, CA 95153
(408) 227-9540
tguster@greatoakswater.com

July 19, 2019

Sent Via Email

Vanessa De La Piedra, P.E. (vdelapiedra@valleywater.org)
Unit Manager
Groundwater Monitoring and Analysis Unit
Santa Clara Valley Water District

George Cook (gcook@valleywater.org)
Associate Engineering Geologist
Groundwater Monitoring and Analysis Unit
Santa Clara Valley Water District

Dear Vanessa and George:

By letter dated January 7, 2019, I provided, on behalf of Great Oaks Water Company (Great Oaks), comments and questions about the October 2017 HydroMetrics WRI[1] Preliminary Zones of Benefit Study (Preliminary Study). A copy of my January 7, 2019 letter is attached.

Following that letter, we met and discussed many of the comments and questions. Since then, a new draft of the Preliminary Study dated April 2019 has been created and circulated for comment (April Draft). It is my understanding that the Preliminary Study may be presented to the Santa Clara Valley Water District (Valley Water) Board of Directors as soon as August 27, 2019.

None of the deficiencies in the data relied upon by the Preliminary Study have been rectified. The April Draft acknowledges the data deficiencies and addresses those deficiencies with broad assumptions about benefits from Valley Water activities directly or indirectly related to groundwater. Because the deficiencies in the original draft of the

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[1] HydroMetrics WRI now appears to be known as "Montgomery & Associates."

Preliminary Study have not been addressed or corrected, Great Oaks' concerns remain the same.

Rather than address the deficiencies in the Preliminary Study, the April Draft glosses over those deficiencies and emphasizes assumptions for which there is no supporting data. The April Draft even includes this statement: "If data or modeling demonstrates that an area benefits from a District activity over *any* time period, the area is assumed to benefit from that activity over *all* time periods." (April Draft, p. 29 (emphasis added)) At the same time, the Preliminary Study includes actual data showing no measurable benefit from District activities during certain periods of time – facts that refute the assumption of benefits over "all periods of time."

It must be noted that the City of Palo Alto and Stanford University have also raised concerns and objections to the Preliminary Study and the April Draft, and those concerns and objections are both well-founded and unaddressed by the April Draft. The same concerns about the broad assumption of benefits simply due to "hydrogeologic connectivity" raised by Great Oaks are made by both the City of Palo Alto and Stanford University. Those concerns remain and are well-articulated in the comments provided from the City of Palo Alto and Stanford University.

Great Oaks met with Valley Water staff and a representative of the firm that prepared the Preliminary Study. Great Oaks was open and honest about its concerns. During that meeting, Great Oaks emphasized that relying upon assumptions without supporting data raise issues rather than justify charges for actual or assumed benefits from Valley Water activities. As Valley Water well knows, the charges levied by it for the "benefits" of its activities have been the subject of legal challenges for more than a decade. Great Oaks' efforts to solve the legal issues by pointing out the obvious deficiencies in the Preliminary Study were, however, to no avail.

It was long past due when Valley Water decided to evaluate the Benefit Zones, and there is no doubt that the lack of data supporting the long-assumed benefits caused concern among those at Valley Water responsible for legal compliance. But ignoring that the data collected does not support the allocation of costs for Valley Water activities is not a reasonable approach to solving the long-standing issue of cost allocation. Great Oaks encourages Valley Water to properly use the data collected, especially when that data refutes ongoing assumptions and the allocation of costs to those paying the groundwater charges.

Respectfully submitted,

Tim Guster

Timothy S. Guster
Vice President and General Counsel
Legal and Regulatory Affairs

Enclosure (January 7, 2019 letter)

Comments Submitted to Los Altos Hills Town Council

April 18, 2019 Meeting

Supplemental No. 2
AGENDA ITEM #2.E
Distributed 4/17/19

DRAFT

Roy B. Woolsey
Los Altos Hills, CA 94022

17 April 2019

Mayor and Members of the City Council
Town of Los Altos Hills
26379 Fremont Road
Los Altos Hills, CA 94022

Dear Mayor and Members of the City Council:

The purpose of this letter is to alert you to some issues regarding the 4/18/19 Santa Clara Valley Water District presentation to Council, and questions you should ask during the presentation. The "bottom line" is that SCVWD has no basis for any groundwater production charges to well owners in LAH.

By way of background: The Santa Clara Valley Water District Act by the California Legislature gives SCVWD the authority to collect groundwater charges for the production of water from areas which benefit from SCVWD groundwater recharge activities. Groundwater levels in Los Altos Hills are 40 to 50 feet higher than the groundwater levels elsewhere in Santa Clara County that are recharged by SCVWD, so our wells do not benefit from this recharge activity. This is because strata in LAH includes layers of vertically-oriented clay strata that act like a wall or dam to largely block water flow between LAH and the valley, and LAH aquifers are recharged naturally from the hills to the southwest of us. After years of my arguing this point with SCVWD, the District apparently admits this is the case by stating on its 6th slide, "Well users would no longer fund recharge on valley floor."

So instead of arguing that our wells benefit from any recharge activity, SCVWD argues (5th slide) that it delivers treated water to our area through the water sold to Cal Water and that this reduces groundwater demand from geologic formations in LAH and therefore improves groundwater supply – an argument which makes no sense and sounds like just trying to find any excuse to charge us, given that most of LAH gets its water from Hetch Hetchy through the Purissima Hills Water District and any improvement in groundwater levels from PHWD water is not due to SCVWD.

I and several other well owners in LAH are working with a professional geologist to firm up these arguments to prove that SCVWD has no basis for any groundwater charge to our wells. So here are questions for you as Councilmembers to ask during the presentation regarding the benefits to LAH:

1. How can SCVWD argue that the delivery of water treated by SCVWD reduces demand for groundwater and therefore improve groundwater levels, when most of water used by LAH residents is provided by Purissima Hills Water District, which gets 100% of its water from Hetch Hetchy?

2. Given this error relating to SCVWD-treated water deliveries through Cal Water, how can SCVWD justify any charges to LAH well owners, given the provisions of the SCVWD Act that only give SCVWD authority to collect groundwater production charges from well owners that benefit from its activities?

3. Don't most benefits to LAH listed on the 5th slide apply to all residents of LAH, and not just to well owners? Do the very few benefits that do (well permitting, water quality testing) justify only a 30% reduction in charges noted on the last slide, rather than a 95% or 100% reduction in charges?

Yours very truly,

Roy B. Woolsey

Supplemental No. 1
AGENDA ITEM #2.2
Distributed 4/17/19

DRAFT

Deborah Padovan

From: Kit Gordon < >
Sent: Tuesday, April 16, 2019 6:32 AM
To: Deborah Padovan; Nichol Bowersox
Cc: Gary Kremen
Subject: Ground water charges in Los Altos Hills

Dear Mayor Spreen and Council members Corrigan, Wu, Tankha, Tyson, Public Works Director Bowersox,

I support groundwater pumping charges and monitoring in Los Altos Hills.

Groundwater, especially in the hills, is more interconnected than previously managed. Water can travel along fault lines and geologic cracks. The long overdue Sustainable Groundwater Management Act of 2014 **requires** water agencies to halt overdraft, including groundwater pumping in our Town.
Although Valley Water supplies water to 1/3 of our residents the agency serves our entire community in many ways. Los Altos Hills has received several grants & programs for flood protection on Adobe Creek Reach 5 and massive, multi year invasive plant (highly flammable Arundo donax, aka Giant Reed) removal on Adobe Creek. We have received multi year grants to restore Byrne Preserve, O'Keefe Preserve and a new grant to improve water quality in the wetlands on Westwind Barn property. In addition, Valley Water's many countywide programs benefit the ecological & economic health of Santa Clara Valley, serving all residents. Valley Water's most important responsibility is groundwater management. Without the management of the Santa Clara Groundwater Basin under Silicon Valley, the economy of Silicon Valley would collapse (as would our property values and our quality of life).

Groundwater in Los Altos Hills feds our creeks, riparian corridors, provides water for deeply rooted trees, and adds water supply to the Santa Clara Basin. Even when water is not visible in the creeks, water continues to flow underground. Groundwater keeps our foothills green.

As our climate warms, groundwater protection becomes paramount for the ecological health of our community.

Sincerely,
Kit

DRAFT

May 1, 2019

The Honorable Roger Spreen
Mayor of Town of Los Altos Hills
26379 Fremont Road
Los Altos Hills, CA 94022

Subject: Presentation to the Town of Los Altos Hills Council on the Groundwater Benefit Zone Study

Dear Mayor Spreen:

I wanted to express my appreciation to you and the Town of Los Altos Hills Council for allowing the Santa Clara Valley Water District (Valley Water) to present information on our Groundwater Benefit Zone Study at your April 18, 2019, meeting.

As noted during the presentation, the good news is that rates for existing well owners in Los Altos Hills will be decreasing by an estimated 29 percent. As you know, most of the groundwater in the county does not come from rain soaking directly into the soil but from water purchased by Valley Water or stored in our reservoirs that is put into the ground. As a result of a science-based study, Valley Water is considering changing the boundaries of the two existing groundwater zones to six more granular groundwater zones, to ensure well users pay a fair, equitable rate based on the benefits received and the water they use. The proposed boundary adjustments and subdividing into more zones will not increase our revenue.

There were several public comments made during the presentation and written comments were also submitted to the Town Clerk. Although Valley Water staff responded to the comments during the presentation, we encourage interested well users to provide additional input through upcoming “open houses” (see the attachment for open house dates, times, and locations), individual meetings, or directly to Valley Water staff. Any policy changes including updating zone changes require Valley Water Board approval, and the Board is expected to consider the proposed zone changes this June. Also, our staff is in communication with Dr. Roy Woolsey, who was one of the commenters, to meet soon to discuss the technical questions he raised. Thank you again for allowing us to present and for the thoughtful questions posed by the Council during the presentation.

Sincerely,

SCVWD

Gary Kremen
Director, District 7

P.S. Really enjoyed the captivating discussion on waste management issues ☺

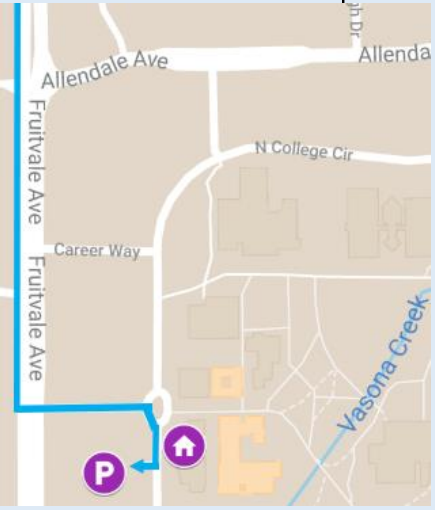
Attachment: Groundwater Benefit Zone Study Open House Information
cc: Board of Directors (7), N. Camacho, N. Hawk, R. Callender, D. Taylor, G. Hall, V. De La Piedra
vd:fd
0501a-l

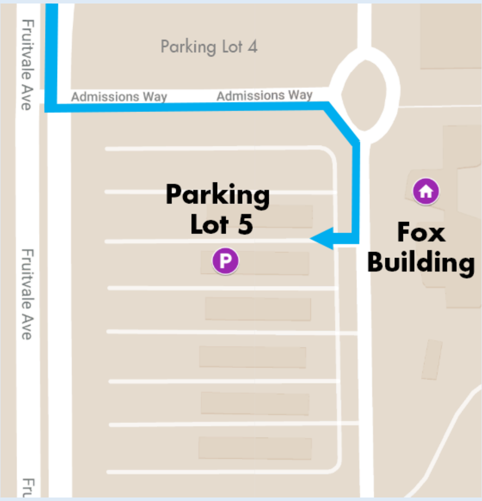
North County Open House

Tuesday, May 7, 2019 6:00PM – 8:00PM	**West Valley College** **Fox Building** (near Lot 5) 14000 Fruitvale Ave. Saratoga, CA 95070

You can enter the following on your smartphone GPS app (Google Maps, Waze, Apple Maps): **"Parking Lot 5, Saratoga, CA"**

*Permits will be provided by staff when you enter Lot 5

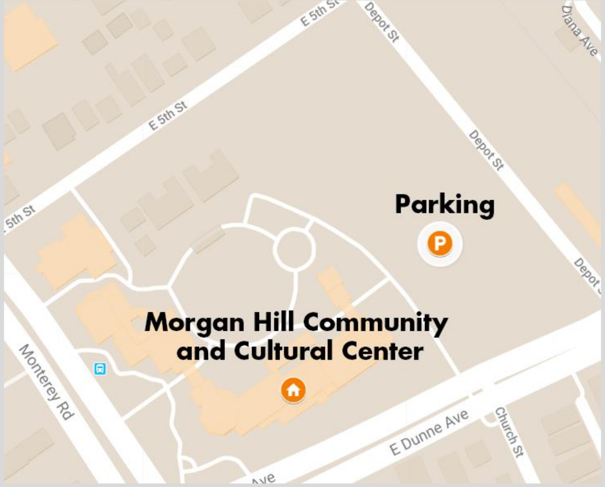




South County Open House

Tuesday, April 30, 2019 6:00PM – 8:00PM	**Morgan Hill Community and Cultural Center** (El Toro Room) 17000 Monterey Rd. Morgan Hill, CA 95037
added Wednesday, May 8, 2019 6:00PM – 8:00PM	**Morgan Hill Community and Cultural Center** (Poppy Jasper Room) 17000 Monterey Rd. Morgan Hill, CA 95037

*Public parking is available in front of the center.



RSVPs are highly encouraged: rsvp@valleywater.org

Carol Meyer, Los Altos Hills Resident Comments

Carol Meyer
26007 Torello Lane
Los Altos Hills, Ca 94022
June 27, 2019

George Cook
Valley Water District (via email)

Dear George,

This letter is in support of Staff recommendations in the forthcoming vote on new zones within the Valley Water District to not place Los Altos Hills well owners into Zones B-1 and B-2. This will mean that Los Altos Hills well owners will not be charged for water extraction. I understand the Board vote is to take place in August of this year.

As you know, I hired Langan Engineering and Environmental Services, Inc. to conduct an hydrogeological study to determine if the well owners in Los Altos Hills were receiving any benefit from Valley Water. Under separate email Langan has forwarded the study slides that were presented at a special meeting of well owners and representatives of Valley Water. The preliminary conclusion of this study was that Los Altos Hills well owners are in distinct geological formations not benefiting from California Water Company/Valley Water activities and, as such, should be excluded from water extraction charges. After the meeting, Langan requested well data from Valley Water for all wells in Los Altos Hills so that they could further confirm their preliminary findings by including all well data from Los Altos Hills.

I also filed a Freedom of Information Act request to get all well data for well owners in Los Altos Hills, which would give the Hydro-Geologists the data that they strongly suggest will confirm the preliminary results.

However, since Staff is recommending removal of Los Altos Hills from Zone B-1 and B-2 I would like to withdraw my Freedom of Information request for Los Altos Hills well owners at this time. I believe this withdrawal is in the best interests of Valley Water and myself to conserve time and effort. I do reserve the right to reinstate my request if the board does not adopt the staff recommendations.

I want to personally thank you and Gary Kreman for arranging the meeting we had with Dorinda Shipman from Langan, my attorney Greg O'Hara, many well owners in Los Altos Hills , and Valley Water Personal and Staff. I appreciated the attention given to Langan's presentation and conclusions and the effort to take the data into consideration in Staff's recommendations to the Board.

Very truly yours,

Carol Meyer

Saratoga Country Club Comments and Valley Water Response

Saratoga
Country Club

July 17, 2019

Santa Clara Valley Water District
Attn: George Cook
5750 Almaden Expressway
San Jose, CA 95118

Dear Mr. Cook,

I want to thank you and your colleagues for taking the time to meet with us at Saratoga Country Club to discuss the proposed changes to the Valley Water District's well zones.

On behalf of our Membership, the Board of Directors and Management of Saratoga Country Club strongly recommends that the proposed zoning changes be denied. Not only would an inclusion into the groundwater benefit zone certainly be punitive to our club, but it would also disincentivize the club to explore the possibility of a new well in future, forcing us to use 100% treated drinking water to irrigate our course.

We at Saratoga Country Club pride ourselves in seeking ways to conserve water while maintaining healthy turf. As an example, the Club spent more than $250,000 on a state-of-the-art irrigation system upgrade that can control every head separately. This avoids overwatering specific areas of the golf course. Also, our well water is only used for irrigation and does not go into the sewer. Any water not absorbed by the turf should theoretically help recharge the aquifer. We look forward to receiving recommendations from the SCVWD on other ways we could help conserve water.

Please keep us informed of any updates on this issue and also to the proposed date of the public hearing, as we would like to attend.

Respectfully,

Steven Gordon
President – Saratoga Country Club

21990 Prospect Road, Saratoga, CA 95070-6541 • 1 (408) 253-0340 • Fax 1 (408) 253-4056 • Website: www.saratogacc.com

Valley Water

Clean Water • Healthy Environment • Flood Protection

August 1, 2019

Mr. Steven Gordon
Saratoga Country Club
21990 Prospect Rd
Saratoga, CA 95070-6541

Subject: Response to Saratoga Country Club Comments on the Groundwater Benefit Zone Study Recommendations

Dear Mr. Gordon,

Thank you for your letter dated July 17, 2019 providing feedback on the groundwater benefit zone study. The Santa Clara Valley Water District (Valley Water) would like to provide an update on the study progress and recommendations. In the past few months, we have held three public open houses, answered numerous e-mail/phone inquiries, and met with well users including the Saratoga Country Club. Through this robust community outreach effort, Valley Water received valuable input and site-specific information from well users, which led staff to revisit the technical data and amend the recommendation for proposed zones.

The amended recommendation does not include the two new zones previously proposed along the western edge of the Santa Clara Valley. This is good news for the Saratoga Country Club as it means your groundwater wells are no longer recommended for inclusion in a groundwater benefit zone. If these recommendations are adopted by the Valley Water Board of Directors, the Saratoga Country Club would not pay for groundwater pumped from onsite wells.

Staff plans to present the amended recommendation to the Valley Water Board of Directors on August 27, 2019. More information is available at https://www.valleywater.org/how-we-operate/board-meetings-agendas-minutes. Also attached are updated frequently asked questions. Thank you again for your interest in the study, and for taking the time to meet with us and provide feedback. If you have any questions, please contact me at (408) 630-2964 or gcook@valleywater.org.

Sincerely,

George F Cook Jr

George Cook, P.G.
Senior Water Resources Specialist
Groundwater Management Unit

Attachment: Groundwater Benefit Zone Study Frequently Asked Questions (Updated June 2019)
ecc: Cameron Tana, Montgomery & Associates
G. Hall, V. De La Piedra

Groundwater Benefit Zone Study Frequently Asked Questions

1. What is a groundwater benefit zone?

Maintaining sustainable groundwater is a key part of Valley Water's mission to provide safe, clean water to Silicon Valley for a healthy life, environment and economy. A groundwater benefit zone is an area where our activities help protect and replenish groundwater supplies. Groundwater pumping charges collected in the groundwater benefit zones fund these activities. These charges are paid by owners and operators of groundwater wells (Well Users) based on the amount of water they pump. Valley Water charges only those Well Users in areas that benefit from Valley Water activities.

If you live within a groundwater benefit zone but do not pump groundwater, you do not have to pay the groundwater charge.

2. Why did Valley Water do this study?

The groundwater benefit zones were first developed in the 1960s and 1970s. Since that time, Valley Water activities to protect and replenish groundwater have changed. Knowledge about the zones that benefit from our activities has increased. To ensure Well Users are charged fairly and equitably, Valley Water hired a team of experts to conduct a science-based study of how to best define the groundwater benefit zones. The study is intended to provide Valley Water with a scientific, transparent basis for evaluating the current zones and proposing any changes. Total Valley Water revenue will not change as a result of any changes to the zones.

3. How was the study conducted?

The study was conducted by a consulting company specializing in developing, protecting, and managing groundwater and surface water resources. The study looked at how water flows underground using data from the U.S. Geological Survey and other agencies. Local data was also used to understand the effect of Valley Water activities on groundwater levels. The study was reviewed by an independent committee of technical experts, who found the study approach and results to be thorough and equitable. To learn more about the study, you can view the preliminary study report at: https://www.valleywater.org/gwbenefits.

The zones proposed in the preliminary study report were created by grouping areas that benefit from similar Valley Water activities, which include:

- replenishing groundwater with local and imported surface water,
- delivering surface water as an alternative supply in lieu of groundwater pumping,
- protecting groundwater from pollutants, and
- promoting water conservation.

4. Did the recommended zones change as a result of the stakeholder engagement process?

Yes. The consultant's preliminary study report recommended replacing the existing two zones with six zones. In addition to the consultant's technical study, Valley Water also sought and considered input and site-specific information from Well Users. Considering all available information, Valley Water staff now recommends a total of four zones. Staff believes there is ample evidence of benefit from Valley Water activities within these zones. Other areas may receive benefit from Valley Water activities; however, staff believes that additional geologic and groundwater data would be needed to fully justify adoption of groundwater charges for these other areas.

5. **How do I know if my well is recommended to be included in a groundwater benefit zone and what the potential impacts would be in my location?**

   Our Groundwater Benefit Zone Web App allows you to search your address, State Well number (e.g., 06S02W22G005), or Assessor's Parcel Number. This app provides information on existing and recommended zones, as well as preliminary rate estimates: https://gis.valleywater.org/ZoB/. In June 2019, this app was updated to reflect the zones recommended by Valley Water staff.

6. **When will the proposed zone changes take effect?**

   The proposed changes would only become effective if approved by Valley Water's Board of Directors. Staff plans to recommend changes to the Board in late summer of 2019. If changes are adopted, groundwater rates for the new zones would not be effective until July 2020 or later.

7. **I use a well for my water supply but am not currently in a groundwater benefit zone. If the proposed changes are approved and my well is added to a zone, how much will it cost me?**

   The cost to individual Well Users will vary depending on which zone they are in since each zone benefits from a different group of Valley Water activities. The cost will also depend on how much groundwater is pumped and the final rate adopted by the Valley Water Board of Directors. Average domestic groundwater use is 2,500 cubic feet per month, or 0.7 acre-feet per year. If you pump that amount, we estimate your groundwater charge assessed by Valley Water would be:

   - $76 per month if your well is in North County (north of the Coyote Valley).
   - $18 to $27 per month if your well is in South County (Coyote Valley south to Gilroy).

8. **If my well is already in a groundwater benefit zone, will my groundwater charges change?**

   If the recommended zone changes are approved, your groundwater charge would depend on location. Based on average domestic use (2,500 cubic feet/month), we estimate the charges would:

   - Increase or decrease by less than $2 per month for wells located in the valley floor, where nearly 90% of wells are located.
   - Decrease by $8 per month for wells located in the foothills of the Santa Cruz Mountains, above the flat valley floor.

9. **If Valley Water removes my well from a groundwater benefit zone, will I receive a refund? Why have I been paying if I receive no benefit?**

   The existing groundwater benefit zones (W-2 and W-5) were established based on the best available information in the 1960s and 1970s. Valley Water determined at that time that your area was benefitting from our activities. Our activities have changed over the last 40 years, and we know more about the groundwater basins. We now have decades of additional data to update the zones to ensure they fairly and equitably reflect benefits received.

   The charges collected relate to the groundwater benefit zones adopted by the Board and remain in effect until the Board adopts changes. Staff will recommend to the Board that Valley Water neither make refunds to those that are removed from a groundwater benefit zone, nor seek payment for past pumping from those that are added to a zone.

10. **Where can I find more information?**

    Please visit our study website at www.valleywater.org/gwbenefits. Project manager George Cook can also be reached via email at gcook@valleywater.org or by phone at (408) 630-2964.